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ABSTRACT

Chanute Air Force Base was the first military training center to undertake an extensive investigation of the use of the PLATO IV system in technical training. The service test was to compare a conventionally taught course in general vehicle maintenance with a course taught with computer-based instructional materials. Part I of this document is the final report of the project and discusses site history and management efforts. Topics include the research agreement, selection and training of PLATO authors, evolution of the project management, lesson development procedures, and Instructional Systems Development (ISD) management of the service test. Written by personnel from the Computer-based Education Research Laboratory of the University of Illinois, who acted as evaluation, instructional, and programming consultants for the service test, Part II is a chapter-by-chapter critique of the final report. (Author/JAB)

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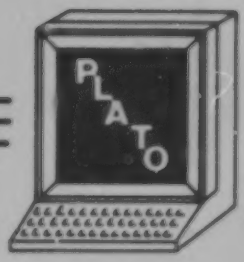

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CRITIQUE AND SUMMARY OF THE CHANUTE AFB CBE PROJECT

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FOREWORD

The School of Applied Aerospace Sciences at Chanute AFB, Illinois, was the first military training center to undertake an extensive investigation of the use of the PLATO IV system in technical training. This research was sponsored by the Advanced Research Projects Agency (ARPA) of the Department of Defense and the Air Training Command (ATC) of the United States Air Force. ARPA provided hardware and hardware support while ATC staffed the project.

It was originally intended that the project have 25 PLATO IV terminals. However, by the project's end 30 terminals were, and still are, in place at Chanute. These extra terminals were necessitated by the practical demands of using the PLATO system as an operational medium of instruction. Each of these terminals is equipped with a graphic display panel, touch panel, and microfiche slide selector.

Historical Summary

ARPA funding began in July, 1972, and ceased in June, 1976. During this time, the service test went through four distinct phases. Each phase was characterized by distinct modes of management and objectives.

Phase one. The initial phase of the service test was characterized by uncertainty in leadership, objectives and orientation. The leadership and objectives both underwent several changes during this phase. Likewise, the orientation of the project was initially towards producing courseware for a large scale test of computer-based technical training. After some time this was given up and interest shifted from a primarily operational emphasis to one of research. This vacillation of the project was probably a result of lack of active interest on the part of the responsible Air Force agencies.

Phase two. When a more active interest in the service test was taken, the project was put in the hands of an experienced curriculum designer and was given specific objectives During this phase, CBE materials were to be produced for use in operational training. Any research objective became incidental to that of producing courseware for Air Force trainees. By the modification of some materials from the first phase and creating the rest, this objective was met. The use of the resulting CBE materials by Air Force trainees has resulted in a rich source of data concerning the use of CBE in a military training environment. This phase came to an end in June, 1975.

Phase three. Following the validation and implementation of these materials, the service test undertook some small researches and courseware development efforts. An evaluation of this latter part is found in Chapter IX of Dallman et al.(1977).

Phase four. When ARPA funding stopped in June, 1976, ATC funded a brief follow-on study of three months. During this period information was to be gathered concerning specific benefits of PLATO use. These studies focused on the cost and times savings due to PLATO use, the efficiency of PLATO-based testing, and the volume of trainess that could be trained with the PLATO courseware developed during the first two phases. This study was completed in October, 1976. The three studies of this phase are reported in Main (1977).

The information gathered in the fourth phase provided a basis for the Chanute Center Commander to request funding from ATC for the use of PLATO as an operational training medium at Chanute AFB. This funding was provided so that the 30 PLATO terminals presently located at Chanute are currently delivering computer-based technical training to Air Force trainees. This training largely consists of PLATO lessons

developed during the first two phases of the service test. They are now being used at a approximate rate of 7000 student contact hours per year with an estimated yearly flow of 350 trainees.

This volume is concerned almost exclusively with the first two phases of the service test. This period of the service test accounted for almost all of the CBE courseware and most of its data on the use of CBE in a military training environment. In addition to a wealth of data, these phases present some very valuable lessons in the management and administration of such a service test. Because of the importance of these lessons and data and because the later phases of the service test did not add substantially to what was already known, it seemed appropriate to focus attention on the first two phases.

The Critique and Summary of the Service Test

Part One. Part One gives a fairly detailed summary of the history of the service test's first two phase. During the first phase, the service test floundered. The sources of the service test difficulties both at the site of the test and from ATC and AFHRL would be evident to any casual observer of the service test. Neverthless, in such matters it is always good to have one's intuitions about a situation confirmed. The second phase of the service test serves this purpose. At the beginning of that phase, most of the apparent shortcomings of the first phase were eliminated. The outcome of the second phase has already been mentioned.

Part Two. Part Two is a commentary on the Evaluation of PLATO IV in Vehicle Maintenance Training (Dallman et al., 1977). Part Two is intended to be read in this evaluation report. Its Foreword (p. 62) describes its purpose and scope.

THE CHANUTE AFB PLATO SERVICE TEST: SITE HISTORY AND MANAGEMENT

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PART I
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ESTABLISHMENT OF THE AIR FORCE SERVICE TEST

Research Agreement

The first research agreement that governed the United States Air Force's service test of the PLATO IV system was signed by the involved agencies in July, 1972. The projected three year service test was, in the words of the agreement, to determine the "cost effectiveness, acceptance, and incorporability (into on-going training), and reliability" of computer-based education (CBE) in a military training environment. The research agreement also outlined the responsibilities of the agencies that would be involved in the service test. These agencies were the Air Training Command (ATC), the Air Force Systems Command Human Resources Laboratory (AFHRL), the Advanced Research Projects Agency (ARPA) of the Department of Defense, and the Computer-based Education Research Laboratory (CERL) of the University of Illinois. The following summary of the responsibilities of each of these organizations is abstracted from this research agreeement.

The ATC School of Applied Aerospace Sciences at Chanute Air Force Base, Illinois, was designated as the site of the service test. At that site, ATC was to provide space to house 25 PLATO IV terminals, students for both the instructional materials in the conventional media and the parallel computer-based materials to be written, and a staff of eight full-time members to write and implement the computer-based materials. The task of documenting these materials and their production was also given to ATC. Except for the PLATO IV terminals and their communications costs, ATC supplied almost all of the physical and personnel resources for the test.

Through a contract with the University of Illinois, ARPA furnished those resources which were not provided by ATC. ARPA's support consisted of the installation and maintenance of 25 PLATO IV terminals along with the funding of communications to and time on the PLATO IV system's computer located at CERL. The terminals were to be equipped with slide selectors, touch panels, and audio devices so that a full capability for computer-based education would be available for the service test. ARPA also provided funds for CERL to train ATC and AFHRL personnel in the TUTOR language, curriculum development, operating dynamics, and instructional capabilities of the PLATO IV system. The Military Training Centers (MTC) group at CERL was to carry out the initial training for the Air Force service test and give advisory assistance in curriculum development and use of the PLATO IV system for the duration of the project.

The remaining major participant in the service test was AFHRL. This laboratory is responsible for all Air Force research in the realm of behavioral sciences and personnel resources. Thus the task of providing overall guidance and of designing and carrying out an evaluation of the service test naturally fell to AFHRL. Specifically, according to the research agreement, AFHRL was responsible for:

1) providing direction and monitoring of the service test,
2) deriving, implementing, and monitoring measures of student and instructor attitudes as well as performance,
3) consulting on instructional systems development, instructional materials, and media devices,
4) consulting on the incorporation of PLATO IV into an on-going training environment and on the use of PLATO and the TUTOR programming language,

5) serving as the primary point of contact to ARPA on all matters pertaining to the University of Illinois contract,

6) providing quarterly letter reports of progress, an annual summary report of progress and findings, and a final report at the conclusion of the experiment.

Located at Lowry AFB, Colorado, AFHRL is about 900 miles from Rantoul, Illinois, the location of Chanute AFB. Thus, AFHRL was tasked with direction of a project in which it had almost no investment in material resources from a distance that made vigilant monitoring and accurate communications difficult at best.

The service test to which these organizations were to contribute was orginally intended to compare a conventionally taught course with computer-based instructional materials. The General Purpose Vehicle Maintenance Course (GPVC) (3ABR47330) was selected for the purposes of this comparison.[1] This course teaches a variety of skills including inspecting, servicing, testing, adjusting, trouble-shooting, and repairing general purpose automotive vehicles, such as light trucks and automobiles. The variety of topics covered in the course indicated that it would provide a good opportunity for the exploration of the

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[1]The verbal designation of this course from service test documents is unclear. Some refer to the course as the General Purpose Motor Vehicle Maintenance Course; others, as the General Purpose Vehicle Repairman Course; and still others, as the General Purpose Vehicle Maintenance Course. Despite the disagreement on names, all documents agree that the course is officially designated by 3ABR47330. For simplicity of reference here the course will be designated GPVC for "General Purpose Vehicle Course."

potentials and limitations of computer-based education. The course, as it was conventionally taught, primarily employed programmed texts and took 12 weeks for students to complete. the projected computer-based course was intended to duplicate the objectives of the existing course point for point while teaching them in a self-paced mode. By self-pacing the course, it was expected that substantial time savings would be realized.

The eight staff members who were to develop the computer-based materials were to be under the authority of the GPVC supervisor. By having charge of both the experimental and conventional courses, it was thought that he could insure that the computer-based materials taught the same objectives as the conventional materials. In addition to the guidance of the course supervisor, the Training Research Applications Branch (TRAB), the School's evaluative branch, held the responsibility jointly with AFHRL of devising an implementation and evaluation plan for the service test. Thus, the PLATO staff was under the influence of three distinct sources--the GPVC chief, the TRAB, and AFHRL. Fragmentation of the authority over the PLATO service test later contributed to several of the difficulties that plagued the project.

The research agreement was approved in June, 1972. The service test itself began on 15 July 1972 and was to continue until 15 July 1975. The final report for the test was due 15 January 1976.

Attempts to Establish a Service Test Implementation Plan

For the first 21 months of the service test, there was no finally approved implementation plan. The absence of such a plan caused several management problems for the administrators of the service test which will be discussed

in the section covering project management before May, 1974. In discussing the establishment of the service test, a major concern will be to give a brief description and chronology of the several tentative implementation plans the project labored under.

First plan. The first implementation plan was a simple elaboration of the research agreement. It was submitted by TRAB to AFHRL for review and comments on November 9, 1972. It called for the development of a PLATO based course parallel in subject matter to the already existing GPVC. The two courses would then be compared with respect to grades, remedial instruction times, course repetition and failure rates along with a variety of ad hoc measures of instructional and cost effectiveness.

The major administrative responsibility, both in daily matters and for execution of an implementation plan, resided with the GPVC supervisor. While the eight staff members who were selected to develop the PLATO materials were directly under his authority, TRAB also exercised some influence on the PLATO staff in an advisory capacity. Because the GPVC supervisor's interest in the PLATO service test was not great, TRAB took a more active part in the test than had been anticipated.

An active role for TRAB in the PLATO service test arose originally from the fact that TRAB's branch chief was the originator of the Request for Training Research (RTR) which led to the Air Force's PLATO service test. His was the plan that called for the computer-based versus conventionally based instruction comparison (Whalen, 1972). Being in some sense responsible for the existence of the service test, TRAB naturally took an interest. This interest combined with its joint responsibility with AFHRL for an implementation and evaluation plan for the test led to the active

supervisory role that TRAB played in the CBE project. Moreover, the fact that there was a TRAB office on the base at Chanute allowed it to monitor progress of the project more closely than the more experienced supervisory personnel at AFHRL.

For four months from the submission of the first implementation plan--from November, 1972 to January, 1973--TRAB personnel and AFHRL project monitors discussed the plan. They were unable to settle on a final version of the plan during this time. At the end of this period, the concept of implementing the service test as suggested by the RTR was questioned and, finally, rejected.

The reasons for giving up the first implementation plan involve problems with the start-up of the project, naiveté in drawing up the original RTR, and changes in the available student populations at Chanute. The first problem relates primarily to management of the project and, hence, can be treated most appropriately in the section discussing the service test's management before May, 1974. It is enough to note here that the problems in getting the test underway were alone sufficient to make the first plan appear extremely difficult to complete at best.

The outline of the service test set forth in the RTR was not thoroughly researched. While it was attractive at first to compare directly conventional and computer-based instruction, it appeared later that such comparison was not desirable because of the nature of the conventional GPVC. This course was taught primarily through the use of programmed texts. Hence, if the computer-based materials were to be developed so that they were comparable for evaluation purposes to the conventional materials, they would not give any demonstration of the capabilities of CBE beyond the evident capability for simulating programmed texts.

Moreover, since the conventional GPVC was already effectively taught with programmed texts, a medium much less expensive than CBE, all hope of studying the cost effectiveness of CBE would have to be given up. (Recall that determination of cost effectiveness was one of the service test's original objectives.) Alternatively, if the PLATO-based materials were written with a view towards fully using the PLATO system's capabilities, the resulting materials would differ so much from the conventional that a comparison of the instructional effectiveness of the two media would be impossible. This was the major theoretical difficulty with the original plan for the service test.

As the Chanute service test got underway, other practical obstacles to the successful implementation of the original comparative evaluation concept appeared. The greatest of these was a sudden decrease in the number of students taking the GPVC. In December, 1972, it appeared that there would not be enough students taking the course to provide data for significant comparison of the conventional and computer-based courses.

Finally, the service test began while the PLATO IV system was being built up to its present configuration. Thus, problems that the managers of the service test had in organizing and managing their project were compounded with frequent breaks in computer service of duration from a few minutes to several days and by delays in delivery of hardware.

These problems, and others which will be detailed later in this section and in the following section on early project management, convinced the administrators at Chanute that the original conception of the service test was infeasible. Simultaneously, the monitors at AFHRL also began to question the original plan. According to the One Year

Interim Report written by members of TRAB, these monitors felt that the two years that were to be spent developing materials for the GPVC could be better spent in answering specific questions concerning computer-assisted instruction (Green, 1973, p.2).

Second plan. On January 5, 1973, TRAB sent to AFHRL a memorandum outlining a new implementation plan for the service test. The new plan would replace the time that was to be spent in developing materials for the GPVC with research into specific questions concerning the applications of CBE to technical training. According to the memorandum, this research would emphasize "direct, simplified, short-term research studies" (Main, 1973a, p.1). As an indication of the scope of the research being contemplated, the following research questions are excerpted from the memorandum (Ibid., pp. 2-3):

> Can PLATO serve as a part-task training device in place of equipment?
> Is PLATO's ability to adapt to a variety of instructional strategies an asset in Air Force technical training?
> Does the ability to employ drill and practice, tutorial, page turning, or copy frames all within the same lesson enhance learning efficiency?
> Can PLATO be programmed to adapt to the aptitude of the student going through the lesson?
> Is the microfiche display an effective add-on to the capabilities of the CBE system? For what types of learning or performance behaviors are microfiche slides useful or necessary?

To study these and similar questions, a plan for the utilization of the project's resources was offered. The plan was an attempt to simultaneously answer some basic research questions about CBE while obtaining information about management and cost aspects of using CBE as an operational instructional medium. It thus represented an attempt to plan a service test which would satisfy the interests of

both AFHRL and ATC.

This memorandum led to a meeting between representatives of the TRAB and AFHRL to set up guidelines for the implementation of new ideas for the service test. At this meeting the following points were agreed upon (Green, 1973, p. 3):

1) The TRAB would be responsible for the day-to-day operation, and HRL [AFHRL] would act as a second-level supervisory body and would publish the service test plan.

2) There would be investigation of the use of PLATO both for computer-aided instruction and computer-managed instruction (CMI).

3) Approximately 80 hours of computer instruction would be developed for CERL community college application.

4) No attempt would be made to incorporate PLATO into the Motor Vehicle Maintenance Course through a formal ISD effort.

5) Due to the inability to create comparable PLATO and non-PLATO courses, no global comparisons, i.e., previously described dependent variables, measuring PLATO versus conventional effects would be made. No attempts would be made to compare training times of lock-step versus self-paced training.

6) Primary purpose would be to use PLATO as a research vehicle directed toward use of CAI/CMI in an operational training setting.

When the original plans for the service test were abandoned, several policy questions which had been determined before were rendered uncertain. These points of agreement represent an attempt to reestablish policy as well as to enunciate intended research questions. Also the first of these points gives TRAB the responsibility of publishing a service test plan.

On the basis of these agreements, AFHRL prepared draft of an implementation plan and, in February, 1973, sent

it to Chanute for comment. The plan was intended as an outline for an evaluation plan for the service test. Succeeding drafts of the plan were to make it applicable to the the day-to-day conduct of the test and its evaluation. As with the previous agreement between AFHRL and TRAB personnel, the plan was motivated by the concern of at once demonstrating the PLATO system in an operational setting and using the PLATO system as a vehicle for answering research questions regarding CBE methodologies (Pennell et al., 1973, p. 1).

The plan's reception by TRAB was less than enthusiastic. In the view of TRAB, the plan suffered from several deficiencies. Among these were the fact that its goals were not stated in measurable terms, that the plan did not clearly set out the division of labor for the project, that it was esoteric, that it was too noncommittal and that it was general where it should have been specific and vice versa (Main, 1973b).

Third plan. To settle points of disagreement and further refine the project's objectives, another meeting was held between TRAB and the AFHRL project monitor. The eventual outcome of this meeting was a draft of a new plan. Both TRAB personnel and the project monitor at AFHRL shared responsibility for writing this document. After some minor revisions, both parties approved it in May, 1973, nine months into the project, and it was sent to ATC for final approval. This final approval was never granted. ATC's reasons for withholding approval were based on the opinion that the plan's objectives were beyond the capabilities of the service test. Perhaps exhausted from the effort of writing implementation plans for the service test, TRAB used the basic ideas of this final attempt to guide the project until a major review was held in May, 1974. It was,

therefore, effectively the project's implementation plan for that period of time despite the absence of full approval.

This plan divided the project into three stages or phases. The first, which by May, 1973, had for practical purposes been exhausted, was devoted to the training of the PLATO authors. Experimentation with the PLATO system would be carried out during the second phase. During the final phase, instructional materials developed in the second phase would be used to collect cost and management data. Five areas of interest were designated for investigation: instructional effectiveness of the PLATO system, instructor/programmer characteristics, human factors and facility requirements, methods of management and conduct of computer-based training, and the economics of using computer-based instructional materials (Green et al., 1973, p. 4).

Although this document was more substantial than the second plan, much of that weight was accounted for by historical and contextual materials included in the plan. Many of the same criticisms which were directed towards the preceding plan could easily be applied to this one. In the absence of any precisely defined objectives, it was directed at using the PLATO IV system as a research vehicle to gather in as many areas as seemed accessible and with whatever methods appeared feasible. This attitude towards the service test is expressed clearly in the introductory discussion of the implementation plan:

> The following sections have been provided to give more detail on the specific techniques and methodologies to be employed in accomplishing the service test goals. A caveat may be appropriate at this point, however. An exploratory service test of the kind planned for this effort must be highly dynamic to produce its most useful product. Therefore, methods and procedures detailed below must be considered mutable and subject to changes dictated by a heuristic approach. (Ibid., p. 9)

This statement reflects accurately the lack of confidence the plan's authors had in it. Better than the pages spent in articulating the guidelines or, as experience showed, hopes for the service test, this statement characterizes the activity of the service test from its beginning until May, 1974.

As stated before, ATC never gave its final approval to this plan. In the absence of any other plan, however, the managers of the service test at Chanute AFB used it as a basis for administering the project until May, 1974. At that time the project was given a full review which resulted in a drastic change in direction. Because this change was so radical and because it resulted in the most productive period of the service test, the change and its consequences are discussed in a separate section on the ISD management. Here, it is sufficient to note that after the May 1974 review, the service test's goals in terms of products and timelines were precisely defined. Moreover, the major effort was to be devoted to producing operational instructional materials on the PLATO system rather than using PLATO lessons individually as research vehicles. Research under the new plan was to be confined to evaluation of the effectiveness of a computer-based medium in an operational setting.

Inherent Defects In The Service Test

Before turning to other aspects of the establishment of Chanute's CBE Service Test, it is necessary to address some comments to the situation which effectively impeded the successful writing of an implementation plan for almost the first half of the project's duration. Interviews with service test evaluators, managers, and authors along with observation of the test throughout its duration have

indicated several contributing factors to this circumstance. Those which were inherent in the service test, and hence directly affected the establishment, will be dealt with here. Other factors will be treated as they become relevant to the succeeding discussion.

The fundamental source for indecisiveness with respect to the service test's objectives can be found in the different missions of the two Air Force agencies responsible for the test, AFHRL and ATC. On the one hand, ATC is concerned with the technical training of servicemen. Its interest, therefore, was to discover how the PLATO system would perform as a technical training medium. AFHRL, on the other hand, with its responsibility for all Air Force behavioral science research and its new commitment to the Advanced Instructional System (AIS), a large CBE system under development at Lowry AFB, was naturally concerned to discover as much as possible about computer-based media.[2] Thus, ATC's interests in the PLATO system were based primarily in its capability to deliver actual instruction and secondarily with the potential of the system to support basic CBE research; priorities of interests of AFHRL in these two areas were reversed from those of ATC.

Practically, the interest of AFHRL in relatively pure CBE research manifested itself in dropping the first implementation plan. If implementing the service test as

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[2]The contract for the AIS system was awarded in May, 1973. AIS was not only to offer self-paced, individualized computer-based instruction to Air Force trainees but also to manage their training by selecting materials and media allocating resources thousands of students. The plans for AIS called for a system which possessed strong resemblances to the PLATO IV system.

originally planned in the GPVC was impossible, surely another course could have been selected for a similar sort of service test. According to personnel involved with the service test at that time, no alternative course was sought. ATC's influence and prejudices are evident by the fact that it withheld approval of any of the implementation plans which were drawn up by AFHRL.

The practical effect of this indecisiveness for the day-to-day management of the project cannot be overestimated. Without an implemention plan, TRAB personnel who were administering the test at Chanute had no real guidelines with respect to both products and deadlines. Interviews with members of Chanute PLATO project indicate that the absence of clearly enunciated, fundamental objectives and the consequent lack of direction from those agencies directly responsible for the service test severely undermined the basis of authority of the project's local managers.

In addition to the clash of fundamental interests of AFHRL and ATC in the PLATO service test, neither of these organizations had had much experience with computer-based education. Moreover, since Chanute was the first military training center to use the PLATO system, CERL could provide little in the way of guidelines or advice in the preparation times for technical training materials. The practical effect of this lack of experience was that none of the people attempting to write an implementation plan had a clear concept of what was feasible in a three year PLATO service test. For example, being novices with the system, they had no reasonable estimate of how many manhours per hour of student instruction would be needed to produce even the simplest sorts of lessons. Thus, any estimate of the magnitude of the project's total output was purely guesswork.

As an example of this sort of guesswork, consider that when the project began it was proposed to use the PLATO system to duplicate most of the non-laboratory instruction in the GPVC. Thus, it was hoped that about 173 hours of instruction would be produced. As far as is known no consideration was given at that time to the work load that such an objective would place on the PLATO authors. In any case, less than six months later the objective for the service test was reduced to 80 hours of CBE lesson material. This objective was essentially halved again in May, 1973, when TRAB and AFHRL made their final attempt to write a joint implementation plan. This last estimate is unique among its predecessors in that it is based on an estimated rate of lesson production, namely, that observed in the early portions of the service test. If objectives about particulars such as the quantity of lesson materials to be produced were so casually made, it is easy to see how the other objectives for which there was no ground for making production estimates would probably be more unrealistic.

Philosophical interlude. In view of this naiveté with respect to CBE, the TRAB managers of the service test should not have been given the license by the AFHRL project monitors and evaluators of being able to change the project's objectives in the face of day-to-day contingencies. Such a policy would be most likely to lead to so many changes in direction that at its conclusion the project would have made very little progress in any given direction. Given this inexperience, the project planners would have been best advised to follow the recommendation of René Descartes on how to embark on projects in which the way to proceed is less than clear. In such cases, Descartes says that one must early establish some rule for action and resolutely follow it. Even if the rule is uncertain and if it is known

to be doubtful, it must be treated as certain. In this way, one would be

> following the example of travelers, who, finding themselves lost in a forest, know that they ought not to wander first to one side and then to the other, nor, still less, to stop in one place, but understand that they should continue to walk as straight as they can in one direction, not diverging for any slight reason, even though it was possibly chance alone that first determined them in their choice. By this means if they do not go exactly where they wish, they will at last arrive somewhere in the end, where probably they will be better off than in the middle of a forest. And thus since often enough in the actions of life no delay is permissible, it is very certain that, when it is beyond our power to discern the opinions which carry the most truth, we should follow the most probable; and even although we notice no greater probability in one opinion than in the other, we at least should make up our minds to follow a particular one and afterwards consider it as no longer doubtful in its relationship to practice, but as very true and very certain, inasmuch as the reason which caused us to determine upon it is known to be so. (Descartes, p. 96)

The sagacity of Descartes' advice was not called into doubt by the Chanute service test, which changed implementation plans at least three times during the first half of its intended duration and never finally fixed on any one plan. Before a final management plan was adopted, the major accomplishment of the service test consisted in the training of the authors. Although the lessons they developed did serve as a basis during the second phase of the project, these lessons had neither the cohesiveness nor polish to be implemented as bona fide CBE lessons. The effect of changing plans so often was that any progress made during one period was canceled out by progress in another.

Selection and Training of PLATO Authors

The selection and training of the PLATO authors was not delayed or substantially impaired by the absence of an implementation plan. By early August, 1972, four civilian and four military authors had been identified by the managers of the service test and were ready to begin training. These eight authors were originally put under the supervision of the chief of the GPVC along with 31 other personnel authorized as instructors in the course. The fact that the authors were under the management of the GPVC chief and of TRAB personnel simultaneously was the source of much difficulty in the early administration of the service test.

The branch chief of TRAB who wrote the original RTR was responsible also for selecting authors for the PLATO service test. Youth was one of the primary qualities he sought in potential PLATO authors. He felt that relatively young instructors would be sufficiently adaptable to revise their educational outlooks and work habits to suit the needs of using the PLATO system as a teaching medium. He hypothesized that not only would the authors have to use new instructional techniques but that they would also have to master a computer programming language and the protocols of working with a computer system.

The TRAB branch chief employed two other criteria in selecting the project's authors. These two criteria were amount of education and willingness to stay with the PLATO service test throughout its duration. Selection of the most highly educated personnel available, in the opinion of the branch chief, would increase the likelihood that the authors would possess the intellectual tools and discipline to master the complex skills needed to author materials on the PLATO system. Learning these skills, moreover, involved so much training that the loss of an author during the service

test would be very costly to the project both in terms of the loss of the investment in the author but also in terms of the time needed to train a replacement.

The criterion that the authors be subject matter experts in the intended areas of CBE lesson development was not of high priority in author selection. Since the pool of instructors from which the authors were selected consisted of GPVC instructors, it was assumed that any of the candidates would be highly knowledgeable in the subject matter of that course. The fact that a premium was placed on youth, however, resulted in the selection of some authors who did not have much experience with teaching or teaching the course's subject matter.

It is not known whether experience in the areas of instructional design and computer science was considered an important criterion in author selection, but, because of available candidates, could not be satisfied, or whether these characteristics were not considered important. In any case, Table 1 shows that the authors selected collectively possessed no experience in the first of these areas and only a little in the second. Finally, the TRAB branch chief was constrained to select four civilian and four military personnel for the PLATO author staff. Table 1 summarizes the characteristics of the staff.

Table 1 shows that some of the primary selection criteria were well met by the authoring staff. With respect to getting staff members to stay for the duration of the project, however, there was much less success. Two of the military authors left the Air Force, and hence the project, after the project was little more than a year old. Another military author left the project after 18 months. Also one civilian author left the project after two years. Because of a scarcity of qualified personnel and bureaucratic

Table 1

Characteristics of the Chanute PLATO Authors in July, 1972

Author	Age	Education	Years teaching experience[a]	Experience with computers[b]	Rank
1	34	H.S. graduate	5	keypunch operator	Master Sergeant
2	32	M.A. (Political Science) M.A. (Sociology) + 9 hrs.	3	none	GS-9
3	29	H.S. graduate + 2 years college	9	none	GS-9
4	26	B.A. (Industrial Ed)	3	none	Staff Sergeant
5	25	B.S. (Biology)	1	keypunch operator	GS-9
6	25	H.S. graduate + 1.5 years college	1	none	Sergeant
7	23	B.A. (Industrial Ed)	2	none	Sergeant
8	23	B.A. (Physics)	1	1 year of college computer science	GS-9

[a]None of the authors had any experience in writing programmed instruction of any sort.

[b]Pennel et al., 1973, p. 6a.

difficulties, satisfactory replacements were generally not made for those authors who departed from the project before the intended completion date of July, 1975.

Acquisition of PLATO IV terminals and Peripheral Devices

The Chanute PLATO service test was allocated a total of 25 PLATO terminals. The delivery of these terminals was to be completed by the end of the second year of the service test. Each terminal was to be equipped with a random access slide selector (Francis, 1976, p. 4), a random access audio playback device (Ibid., 1976, p. 38), and a touch panel (Ibid.,1976, p. 25).

Because of manufacturers' delays, CERL repeatedly revised times the schedules for the delivery of terminals and peripherals. The inability to follow any of these schedules stems primarily from delays in delivery of hardware to CERL from various manufacturers. The delays of the manufacturers on the other hand may be attributed to the fact that much of the hardware for the new PLATO IV system was being manufactured for the first time so that these manufacturers were encountering the problems that usually accompany the assembly of new products. For Chanute, the source of these delays was not important. All that concerned this site was that the delays did exist, that they were long, and that they impeded the ability of the newly trained PLATO authors to develop their skills in using the PLATO system.

Chanute's first two terminals arrived two weeks late in September, 1972. This delay forced the authors to travel daily to the University of Illinois for two weeks to continue to use the PLATO IV terminals there (see Appendix 1). The authors had just completed their TUTOR training at that time. Consequently the importance of getting extensive

exposure to the PLATO system far outweighed the inconvenience of working in an unfamiliar and temporary environment and of commuting between Chanute AFB and CERL, a trip of 18 miles each way.

Another ill effect of the slow delivery of PLATO terminals was that the eight Chanute authors were split into three groups with each group working one of the three workday shifts. (This was possible since PLATO system service was available 22 hours a day.) As the shifts were originally established and remained through June, 1973, two shifts each with three authors did not interact at all. Not only did this arrangement hinder communication within the authoring group, it also often rendered ineffectual the attempts of the TRAB personnel to monitor and guide the progress of the authors. In June, 1973, the shifts were differently staggered to avoid some of these problems. It was not until January, 1974, when the eighth terminal was installed that all of the authors could work the same shift.

The slow delivery of terminals was perceived by the on-site managers as one of the project's biggest problems during its initial stages:

> In the beginning of a project, one additional terminal can make all the difference as far as available terminal hours and flexibility of scheduling. Never knowing when the next terminal would be delivered and always being promised that it would be there the next week added more to the list of frustrations. (Green, 1973, p. 11)

The inability of CERL to deliver Chanute's terminals according to most of the proposed schedules also damaged the confidence of the project adminstrators in CERL's promises for delivery of other hardware. In the case of the touch panels, the lack of confidence had a definite impact on courseware development. Although enough panels were installed for author use, the project administrators refused

to allow their authors to incorporate use of the touch panel into the PLATO lessons even though delivery of a sufficient number was promised by CERL before the students would be using them. Only with all of the touch panels installed would such reliance on them in the PLATO lessons be permitted. For this reason, touch panels were not used in any of Chanute's operational lessons although each terminal was eventually accoutered with one.

The situation with audio devices was much the same as with touch panels. Since the site was not completely supplied with these peripherals, it was decided not to use them in the CBE lessons. In fact, for the entire duration of the service test and the subsequent operational use of the PLATO lessons, there was never more than one audio device at Chanute, and it was seldom, if ever, used.

With respect to the slide selectors the case was somewhat more fortunate. A full complement of these was installed early enough so that the decision to use microfiche in the CBE lessons could be made. The slide selectors, nevertheless, required frequent on-site maintenance and were not found to be reliable by the Chanute authors (Francis, 1976, p. 30). An extensive description of Chanute's experience in preparing microfiche for their lessons may be found on pages 19-32 of Francis (1976).

Service Test Managers

The multiplicity of interests in the Chanute PLATO IV service test has already been detailed in the discussion of the research agreement. It should be recalled that the PLATO authors were officially designated as instructors in the GPVC. At the same time, the entire PLATO service test was under the general guidance of AFHRL which was trying to exercise its supervisory duties from a distance of 900 miles

from the test site. Finally, TRAB personnel located at Chanute AFB acted as on-site project managers sometimes expediting directives from AFHRL, sometimes collaborating with AFHRL in formulating project plans, and sometimes taking the initiative in administering and directing the service test. All in all, it appears that there was an attempt to compensate for the absence of an implementation plan with a surfeit of project administrators.

Of the three organizations directly involved with the service test, TRAB was by far the most important. The original Research Agreement designated TRAB as the

> Technical School OPR [Office of Primary Responsibility] for coordination of the experimental service test with ATC/XPT, AFHRL, ARPA, and the University of Illinois. This office will monitor the research program by developing a programmed action directive for the duration of the three-year research agreement. (Training Research Agreement, 1972)

What monitoring a research program by means of a "programmed action directive" may mean is not altogether clear. However, the TRAB Branch Chief and his staff members were de facto project officers of the service test from its inception until May, 1974.

By "project officers" something less than might ordinarily be understood is meant, for in any effort to direct the project, TRAB personnel had to contend with the fact that the PLATO authors were under the supervision of the GPVC branch chief. Without the cooperation of the GPVC chief, therefore, the influence of the TRAB personnel was limited. Again, without some convergence of goals of ATC and AFHRL, the administration of the project on-site was indecisive at best. An awareness by the TRAB personnel of the diversity of influences affecting TRAB is apparent in the following quote from a documentation of early project

problems:

> It seems apparent that TTOE[3] personnel are the critical link among all contacts concerned with the PLATO effort. Everyone involved with the program at whatever level seems to have their own interests uppermost in mind when any problem about PLATO is brought to their attention. (Green, 1972, p. 4)

Clearly, since its role in the service test was subordinate to that of AFHRL and ATC, TRAB could not administer the project effectively without some convergence of interests of those two agencies and without an approved implementation plan. There were other conditions that together made effective leadership of the project beyond the practical capabilities of TRAB. Among these conditions were frequent personnel changes in TRAB and, consequently, in the PLATO project's administrator during the first two years of the test. These changes along with an assessment of their impact on the project is contained in the section discussing management in the first two years of the project.

Since the leadership of the project changed so often in its first two years it would be difficult to categorize the qualifications of the TRAB personnel. In interviews with members of TRAB's staff, however, one deficiency in particular was emphasized as being especially detrimental to the success of the test. During its first two years, TRAB neither had any staff members experienced in curriculum design nor ready access to Air Force personnel with experience in this field. This deficiency was characterized by a member of the TRAB staff who had held a position of high responsibility in the administration of the project as being the single most important factor in contributing to the relative

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[3]"TTOE" is an internal designation for TRAB.

lack of progress in the project's first two years. He made this assessment in comparing this problem with those of trying to develop an implementation plan that would satisfy both AFHRL and ATC and of trying to undertake an ambitious curriculum development project on a newly assembled innovative CBE system.

It should be recalled that none of the PLATO authors had a significant background in instructional design and that none of them had any background in developing lessons for CBE. It is then easy to see that with this naiveté with respect to CBE instructional design on the part of the authoring staff, the absence of experience in curriculum design could be critical to the project's outcome. It is merely speculation to attribute some of the problems of the project to the absence of a curriculum designer. At another ARPA/PLATO site which was administered by an individual with ten years of curriculum design experience, fewer of these problems arose (Himwich, 1977). This relative competence was not only apparent in daily management of project affairs but also in allocating responsibilities to the staff's members so that the project's long range goals could be achieved.

Summary

The Air Force's PLATO service test had several difficulties which were either inherent in the structure of the test or could be attributable to causes beyond the control of the project's planners and administrators. Since these problems were the causes of several deficiencies in the establishment of the test and because they continued to plague the project throughout its duration, it is fitting by way of summary of the project establishment to enumerate

them here.

The problems that arose in the service test seem to be from three fundamental sources:

1) The two Air Force agencies--ATC and AFHRL--which had primary responsibilities for the service test had different aspirations for the outcome of the project. ATC was interested in PLATO mainly as an operational teaching device while AFHRL tended to view the PLATO system as a vehicle of basic CBE research.

2) The service test began at the same time that the new PLATO IV system was being assembled.

3) Neither among the supervisors of the project nor among the PLATO authors was there any significant experience in curriculum and instructional design.

The first of these has been discussed as a primary reason that no implementation plan was officially adopted for the project. Also, as will be more apparent in succeeding sections of this chapter, it made effective administration of the project at Chanute AFB by TRAB difficult. However, it is clear that the task of managing the project locally and simultaneously serving the interests of ATC and AFHRL could only be successfully completed with the aid of exceptional administrative talent or of exceptionally good fortune. Chanute was blessed with neither.

One of the manifestations of the second of these problems appeared in the delays in the delivery of terminals and peripheral hardware. These delays, in turn, were an impediment to the project authors in practicing skills they had just been taught in author training at CERL. Finally, with the start-up of a computer system as complex and large as the PLATO IV system some difficulties with regard to establishing reliability must be expected. Being the first ARPA/PLATO site and one of the first large sites remote from the University of Illinois, the Chanute service test fell

victim to a number of problems that would not and did not trouble later sites. These problems will be discussed wherever appropriate in succeeding sections of this chapter.

The absence of experience in curriculum and instructional design in the project had its main impact in the manner in which the project authors were administered. It is, therefore, sufficient to emphasize this fact here and discuss it in the section on project management.

SERVICE TEST MANGEMENT BEFORE MAY, 1974

The management of Chanute's PLATO service test underwent several changes in the first portion of the project. These changes are in part attributable to turnovers in the staffing of TRAB which had the responsibility of locally monitoring the project and of coordinating the efforts of the agencies that were involved with the project. Other changes occurred as some workable scheme for administrating the daily progress of the authoring staff was sought. These changes are important because they revealed defects in the original structure of the service test and because they had an effect on the authoring staff. The first part of this section discusses the evolution of the service test management. The second part will note other influences on the management of the project. Finally, the lesson development processes during this phase of the service test will be described.

Evolution of the Project Management before May, 1974

While the leadership of TRAB could not be well directed without a convergence of interests of ATC and AFHRL and without an approved implementation plan, the fact that TRAB underwent a number of personnel changes during the early stages of the project also contributed to TRAB's indecisive leadership at the site level. Which, if any, of these changes were most detrimental is a matter for speculation. However, it can not be doubted that, taken separately or together, they did have adverse influence on the project's outcome.

The first change in local leadership of the project occurred shortly after the authors had completed their PLATO

training at CERL in September, 1972. At that time, the TRAB branch chief left Chanute AFB. This individual, by virtue of his proximity to the University of Illinois, had been aware of the development of the PLATO IV system at CERL. Being excited by the potential of a powerful computer-based educational system, he initiated the project's RTR. Also, the central idea of evaluating the effectiveness of the PLATO IV system by duplicating the already existing GPVC was his. It is not remarkable that enthusiasm for this approach to the service test diminished after his departure in the face of other difficulties to that concept's implementation.

At the time of the departure of the first project officer, one of the psychologists from TRAB's military personnel was assigned as project officer working one-half time on the PLATO project. TRAB's office and that of the PLATO authors were not of sufficient proximity to each another for the new project officer to get a satisfactory feeling for the needs of the project. To remedy this situation, he obtained a desk within the PLATO group. Once he began to have more contact with the PLATO authors, however, his involvement with the project increased. By January, 1973, he was working full-time with the project (Green, 1973, p. 8).

Increased commitment to the PLATO project of all members of TRAB followed that of the project officer. TRAB's staff consisted of two military psychologists, a civilian training specialist, and a civilian secretary. One of the psychologists was already acting as project officer. By early April, the other psychologist and the training specialist were spending a significant portion of their time with the PLATO project also. At that time, in fact, serious consideration was given to the idea of moving the entire TRAB office to a room adjoining the PLATO section (Green, 1973, p. 8).

While TRAB's involvement was increasing, some difficulties between the PLATO group and the other instructors from the GPVC arose. From the outset, the PLATO staff, though part of the GPVC staff, was viewed with some envy by their colleagues who taught the conventional course. It was felt that since the PLATO staff did not have to instruct as conventional lecturers that their situation was preferable to that of the other instructors. Moreover, early in the project there were only two terminals installed at Chanute. Thus, only two authors could use the PLATO system at a time while the other six were left to plan their lessons at their desks. This behavior was judged to be non-productive by the conventional instructors and the GPVC supervisory personnel.

Early in 1973, because of hardware and software acquisition and modification, the PLATO system was unavailable for six weeks. Restricted entirely to desk work, the labors of the CBE authors seemed to be even more unproductive than they had appeared earlier. This appearance, it was argued, had a demoralizing effect on the conventional instructors. To remedy the apparent inequity, the PLATO authors, military and civilian alike, were ordered to take part in custodial duties that required several hours a day of stripping, cleaning, and waxing floors. These duties were even maintained after the PLATO system was once again available on a reliable basis. In fact, it was only after hard and long argumentation from the TRAB project officer that the GPVC Branch Chief was convinced that the PLATO staff had enough to do without these additional duties.

The friction between the PLATO authors and the other GPVC instructors was heightened by the ambiguity in the leadership of the project. On the one hand, the GPVC chief was officially the supervisor of the CBE authors, while on the other TRAB personnel had taken the active role in

administering the project. Again, the GPVC chief "knew little, if anything, about the project" (Green, 1973, p. 8) while members of TRAB had taken the time and trouble to learn TUTOR, the programming language used on the PLATO system, as well as other efforts to help the authors in undertaking the task of developing CBE materials. Thus TRAB, with no official sanction to supervise the CBE authors, was in fact doing so while the officially designated supervisors were taking very little interest in any aspect of the service test.

In early 1973, an attempt was made to alleviate the the ambiguity in leadership of the PLATO projects and to reduce somewhat the friction that had developed between the PLATO authors, as GPVC instructors, and the other course instructors teaching the conventional GPVC. To solve these problems, discussions were begun concerning the feasibility of transferring the authors to TRAB. This transfer was in fact made with the understanding that the PLATO authors would revert to the supervision of the GPVC chief once their materials were completed and were being used operationally. With this change in the management of the project and the involvement of the entire TRAB, the authors were under a single local leadership.

When TRAB began administering the daily affairs of the service test, the need for a larger research component for the project became apparent to TRAB personnel (Green et al., 1973, p. 40). To assist in monitoring this need, TRAB urged AFHRL to meet the terms of the original agreement between ATC and AFHRL and provide an on-site AFHRL representative (Green, 1973, p. 9). In June 1973, AFHRL hired an individual to serve in this role. The view of TRAB towards this appointment was quite sanguine. TRAB anticipated that "This action will insure that research needs under jurisdiction of

Air Force Systems Command and operational requirements of Air Training Command are properly balanced." (Green et al., 1973, p. 40)[4]. An immediate benefit of the appointment was that communications between the service test site and AFHRL at Lowry AFB, Colorado, were improved.

For service test monitor and liaison, AFHRL selected an individual who had been an instructor at Chanute AFB for five years. As an instructor he had probably gained some experience of with instructional design and implementation of instruction. However, there is little in this background that would indicate a competence in evaluation, management, or curriculum design. With experience only in the area of instruction, this individual was not prepared to insure that the service test maintained a "proper balance" between research and operational concerns.

The management role of the AFHPL monitor was very important during the first phase of the service test. Despite his inexperience in the important areas of educational research, curriculum and instructional design, and management, he and the TRAB project officer were very nearly peers in these areas. Thus, his opinions, which were already invested with the weight of his position as AFHRL's representive, generally influenced the project officer's decisions strongly. Together the AFHRL representative and TRAB project officer administered the service test from the time the former assumed his duties in June, 1973, until the first phase of the project was formally reviewed in May,

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[4]This statement is of significance not only as documentation of what role the AFHRL liaison was expected to fill but as an indication that TRAB was aware of the difficulties in trying to administer a project that was to be simultaneously research and operationally oriented.

1974. For this reason, the administration of the project during this period may be justifiably attributed to the "management/evaluation" staff.

During the tenure of this management/evaluation staff, the authors essentially operated autonomously. For most of this time, the project only had four PLATO terminals. To maximize the time that each author could work on the PLATO system, the staff worked three daily shifts. For the authors, working under such conditions decreased somewhat group interactions that are useful in solving problems that arise in lesson development and in utilizing the variety of talents in an authoring group. For the management/evaluation staff, splitting the authors into three shifts meant that the authors often worked without supervision and that their progress was difficult to monitor.

Having established the habit of working autonomously the authors naturally resisted attempts to establish any regimentation in their work habits. This resistance amounted to more than the mere distaste for supervision. On one occasion, when the project was well into its second year, the AFHRL monitor proposed an implementation plan. A strong negative reaction to this plan by the service test authors was sufficient to prevent him from formally proposing the plan to AFHRL and ATC. At other times, the authors, both individually and in groups, undertook to reform the project themselves. With respect to providing some direction to their work, their efforts were as ineffectual as those of the management/evaluation staff. It is, however, noteworthy that they undertook such initiatives while occupying subordinate positions. It is a token of the lack of direction and order that pervaded the project during this phase.

With the possible exception of the first writer of the RTR, the succession of TRAB project officers and the on-site AFHRL representative were all actively engaged in graduate degree programs at the University of Illinois. Two of the TRAB project officers were involved in doctoral programs. One of these officers felt so acutely the demands of simultaneously managing a CBE curriculum development project and of pursuing an advanced degree that he left the Air Force to become a full-time graduate student. Another took leave of his Air Force duties to devote his energies full-time to his graduate program.

It is impossible to assess the overall impact that enrollment in graduate degree programs had on the quality of the management of the Chanute service test. Enhanced backgrounds in education and evaluation were valuable to the management of the project. However, the courses and studies were directed at long-term career objectives and so were more extensive than mere supplementation of knowledge needed to direct the service test. Also, in two cases the commitments of a project officer were radically altered for the sake of continuing graduate studies. It is, therefore, plausible to conclude that their studies on the whole detracted from the performance of their duties as project managers. How much these duties were affected can only be a matter of speculation.

From interviews with service test authors, it has been learned that while members of the management/evaluation staff were enrolled in graduate degree programs, they actively discouraged the CBE authors from undertaking additional coursework themselves. Even though in some cases the authors were interested in taking courses which would have increased their value to the service test, at least one of the PLATO authors had his desire to take courses

categorized as self-serving. (The completion of additional coursework facilitated promotion.) Such criticism appeared to the authors to be hypocritical in view of the fact that some members of the management/evaluation staff were pursuing degrees which would enhance their professional standing. Despite these discouraging conditions, after appealing to GPVC supervisors, at least two of the original eight authors took coursework while working for the service test.

The question of whether or not the authors' perceptions were accurate is not relevant to this report. What is important is how they perceived the managers of the service test. That authors' perceptions were as described is a token of the poor esprit de corps of the service test personnel. To outside observers of the project, the morale usually appeared bad. Such an assessment seems to be corroborated by the service test manager/evaluators who once, in conversation, characterized the attitude of the authors as one of "open rebellion" to the administration of the project.

Lesson Development Procedures

Those interested in planning a CBE curriculum project would never consciously imitate the lesson development procedures employed at Chanute before May, 1974.[5] These

[5]Planners for the PLATO projects at other military training centers frequently included an inquiry into the history of the Chanute service test as an essential part of their preparations. That this project was beset with many problems was well known. They hoped that a thorough knowledge of these troubles would help them to avoid similar problems in their own projects.

procedures were the outcome of several different influences ranging from defects inherent in the establishment of the project to inexperience in curriculum and instructional design. It would be a difficult task and of little use to recount the various attempts made at Chanute to bring some order to the production of lessons. The task would be difficult because, as with the implementation plans, several different procedures were tentatively adopted and of little value since the administration of these procedures was ineffective.

The most instructive view of these practices would be that which sees them as a natural outcome of deficiencies in the establishment and management of the project. This view will be adopted here. No attempt, therefore, will be made to describe completely the development of a CBE lesson from the planning stages to its operational use or to enumerate the number of different lesson development procedures adopted. Unless otherwise noted, any specific mention of procedures will refer to those employed during the tenure of the last TRAB project officer who managed the service test for the major portion of time before the project review in May, 1974.

During the phase of the Chanute service test under discussion, there were no timelines imposed on lesson development by the project management. Rather, each author worked at his own speed on a PLATO lesson until it reached a state of perfection that was satisfactory to him. With no timelines to be met, lesson development was quite slow. A factor lengthening development time was the fact that there were no precisely stated or enforced procedures for lesson development. Thus, the authors became the sole judges of when their lessons were ready for classroom use. The policy of allowing the authors to determine when their lessons are

completed is particularly unfortunate in the early stages of a project. Novice authors frequently tend to be overly concerned with cosmetic and generally nonessential aspects of their lessons when they are not constrained by timelines for lesson production. Without such timelines, an author's boredom is often the major criterion for when a lesson is completed.

Such was the case at Chanute where it was thought to be useful "to determine how long it would take novice programmers and lesson designers to program one student contact hour (Green, 1973, p. 27). For the project's first lessons, each author was asked to select a topic from a given portion of the GPVC for a PLATO lesson and then to begin the task of designing and programing the lesson. Working independently, the authors took an average of 650 hours to complete one student contact hour of CBE material (Green et al., 1973, p. 38-j). Whether or not this figure includes the time needed for trial student runs and lesson revision is not clear. If it does not, the actual time needed to ready one student contact hour by the Chanute PLATO authors may have been as high as 700 hours.

Even for a project's first lessons, 650 hours of authoring time for one student contact hour is an unusually slow production rate. The Aberdeen Proving Grounds required about 400 hours per student contact hour for their first lessons. Aberdeen's first lessons were produced under similar circumstances to those of Chanute with each author being a CBE and instructional design novice and undertaking virtually all of a lesson's development (Himwich, 1977).

Related to the long lesson development times experience during the first phases of the project was the fact that there were no established lesson structures. Instead, since the project officer perceived the major objective of the

test to be research, practically each lesson became an experiment in instructional design. These experiments were frequently designed by the individual author with only the approval of the management/ evaluation staff which was no more experienced in the area of instructional design than the author. Thus, with one lesson designed primarily to test the PLATO system's graphics capabilities, another to experiment with simulation, another to test the effectiveness of microfiche, etc., the CBE courseware took on a somewhat random appearance. This randomness extended not only to the the basic intent of the lesson but also the conventions employed by each lesson for proceeding through that lesson and the requirements for its successful completion by the student. Thus, the first lessons taken as a whole did not have an appearance of belonging to the same course.

Although these remarks have been made in reference to the project's first lessons, they apply in general to all the lessons produced during the period of time under discussion. For the most part, each lesson was designed and programmed to test some aspect of CBE that intrigued its author. The PLATO authors were allowed to take the initiative in choosing the topics of their lessons from the GPVC material, in determining what capability of CBE was to be tested by their lesson, and in designing the lesson to meet the experimental objectives. The role of the management/ evaluation staff during this time was primarily advisory. Their advice apparently did not include guidelines that would have given the lessons the appearance of belonging to the same project or timelines for how long a given lesson should be worked on.

That the authors worked in such a permissive atmosphere appears to be primarily the result of two conditions. The first of these, and probably the most important, was the

absence of service test objectives more precise than a general charter to research aspects of CBE. The second was the lack of experience on the part of the management/evaluation staff in the crucial areas of curriculum design, educational research, and management. With vague objectives and little of the expertise needed to direct a research-oriented curriculum development project, a too-heavy burden was put on the management/evaluation staff of the service test.

The authors had become very used to working independently early in the project. If there were any attempts to impose order on the lesson development processes such attempts would naturally be met with resistance. In an interview, management/evaluation staff expressed the view that the PLATO authors expected some justification for any change in procedure they were asked to make. For such authority, the management/evaluation staff had neither an implementation plan, nor relevant experience, nor precedent to offer. As a result, their attempts for an active management of the project's lesson production were for the most part ineffectual.

Summary

There is no known record of the output of the Chanute PLATO service test during its first 21 months. Several reports indicate the progress at various times before May, 1974, but no summative report exists. Projecting such data from the first annual report (Green, 1973), suggests that the first phase of the service test produced about 22 student contact hours of CBE instruction.[6] Allowing 2 months

[6]The estimate of the total number of student contact hours is derived by projecting the ratio of the total number of manhours available with the total number of student contact hours produced as of May, 1973.

of training time for the eight authors, the rate of CBE lesson production was about 1120 manhours for each student contact hour produced.[7] Also, 80 students were used in testing these lessons as part of their formative development. There is no record of any of these lessons being used without modification as mainline instructional materials at Chanute or as part of structured research. However, 16 of the lessons were modified to be consistent with the objectives of the second phase and were included among the 33 PLATO modules used in that phase.

This estimate of the productivity of the first period of Chanute's service test roughly agrees with those of some service test staff and those of outside programming and educational consultants. Even by doubling these output rates, the productivity would have to be considered poor. In discussing the management, several of the factors contributing to this poor record have been mentioned. In summary, these factors were:

1) the absence of precisely articulated project objectives,
2) the attempt to maintain a simultaneous research and operational orientation to the project,
3) uncertain designation of leadership followed by inexperienced leadership,
4) the absence of structured CBE lesson production procedures,
5) slow hardware acquisition and PLATO system unreliability during the first six months of the service test.

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[7]It is interesting to note that the report from which these numbers are derived gives 445 manhours as the time to develop one student contact hour. Thus, as a rough estimate, the authors were spending more than half of their time in activities not directly related to CBE lesson production.

Although no significance is intended in the order of presentation of these factors, interviews with management personnel have indicated a strong feeling that the first was the major contributor to the service test's lack of productivity during this time. While this factor is surely important in this respect, it seems clear that all five of these factors contributed synergistically to the service test's lack of productivity. Nevertheless, the presence of any one of these would have severely diminished any project's chances for success.

Final responsibililty for the absence of useful activity during the test's first phase must rest with AFHRL and ATC. Had they pursued more actively the tasks of settling on and supporting an implementation plan early in the service test a substantial portion of the 18 month first phase might have been salvaged. Such a course would have contributed to a positive esprit de corps by showing high bureaucratic interest in addition to giving the project a sense of direction which by itself might have boosted morale. Similarly, ATC and AFHRL were in a position to insure that the management/evaluation staff was sufficiently experienced to carry out the difficult task of administrating and monitoring the test. In May, 1974, when ATC and AFHRL finally determined to closely examine the test and take a more active hand in it, the test was put under experienced leadership and entered its most productive period.

ISD MANAGEMENT OF THE SERVICE TEST

Early in 1974, the problems of the Chanute service test came to the attention of the agencies which were materially concerned with the test's outcome. A formal review at Chanute AFB was convened on May 15, 1974, with reprensentatives from ATC, AFHRL, ARPA, the Educational Testing Service, and CERL attending. The presentation offered by the service test personnel reflected accurately the fact that the test had been up to that time a disorganized effort and that little useful information about CBE had been gathered. As a result the service test was put under new management and a new research agreement was drawn up.

The new research agreement called for the Department of Weapons Systems Support Training (WSST) Instructional Systems Development (ISD) chief to take over the management of the PLATO authors from TRAB. This individual was already revising the Special Purpose Vehicle Maintenance Courses (SPVC).[8] It was felt that by using the PLATO system to present the SPVC as revised by the ISD effort a measure of the "true costs and capabilities of PLATO IV in a systems approach to Air Force technical training" could be obtained (AFHRL, 1974).

The new research agreement called for the ISD team to integrate PLATO lessons into the SPVC. These lessons would then be offered with the other revised components of the course as operational training materials. The management plan for the ISD effort states explicitly that "PLATO lesson/learning strategies and methodologies will be limited

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[8]Like the GPVC, the SPVC had several informal verbal designations. The official name of this sequence of courses is 3ABR47231-1/A/B/C.

to presently available hardware and programming techniques" (Gissing, 1974). Thus, rather than regard the PLATO system as a research tool, in the new phase of the service test it would be used alongside other instructional media in an on-going course.

The management plan called for the development of materials to support 88 training objectives. Of these, 50 objectives were knowledge oriented, and 33 of the knowledge oriented objectives were judged to be suitable for PLATO support. Happily, the SPVC and GPVC were not totally dissimilar in their content. With some modifications, lessons from the first phase of the service test could be used to support 17 of the 33 objectives. CBE lessons for the remaining 16 objectives were completed in the time allotted by the management plan. Along with the modified lessons from the first phase of the service test these PLATO lessons became part of the SPVC in January, 1975.

Comparison of the First and Second Phases

Because it was the only phase of the service test that produced a substantial amount of analyzable data on CBE use in military training, the second phase has been extensively documented in reports by the Air Force and CERL. To report on the same aspects of the second phase in the detail that was lavished on the first would largely duplicate what has already been written. For this reason, a bibliography of these reports with a brief description of their contents is included in this section. To supplement these reports and to continue with the discussion of the entire service test, a comparison of important aspects of the first two phases will be drawn.

An important difference between the first and second phases of the Chanute service test was that the second

phase's goals and means of attaining them were carefully articulated at the outset in an implementation plan. This plan laid down the responsibilities of all of the parties involved with the project. In particular, the responsibility for managing the eight PLATO authors was given to the ISD chief while the role of TRAB was relegated to that of liaison for the service test with ARPA, ATC, AFHRL, and CERL. TRAB was also given the responsibility for conducting tours of the PLATO project so that there would be no interference with the PLATO authors' work. For the evaluation activities that were the joint responsibility of the AFHRL representative and TRAB, the plan specified that guidelines were to be drawn up which would preclude the evaluation procedures from interfering with the lesson development.

By simply possessing a management plan, the ISD phase of the service test differed substantially from the first phase. In delineating responsibilities of the various agencies involved in the test, the distinction from the first phase was still more striking. Added to these differences was the fact that the management plan set out timelines for PLATO lesson production and validation. Thus, the new manager of the service test possessed some standard by which to govern the rate of lesson production. In fact, knowing the amount of lesson material needed and the amount already existing, he initially established production rates of 50 hours per student contact hour. Being based on the production rates for programmed texts, this expectation was, perhaps, overly optimistic. Nevertheless, this goal did establish an objective that could be articulated to the authors and could be used as a touchstone to determine progress. Without such a management device, attempts at administering a curriculum development effort are likely to be ineffectual, as was demonstrated in the first phase.

During the first phase, the administration of the service test was placed in hands inexperienced in both curriculum development and sound management practices. The new manager, as ISD chief, was responsible for revising 107 existing courses to improve instructional efficiency while at least maintaining student performance. When he undertook to manage the PLATO service test, he had already carried out revision of about 32 of these courses. In a total of 22 years at the School of Applied Aerospace Sciences, he had occupied a variety of positions from instructor to WSST ISD team chief. He had spent seven years with the ISD team and two years as its chief. Thus, he possessed extensive experience in the designing and administration of curriculum development projects.

Another striking difference between the first two phases of the service test was the manner in which curriculum and lesson design was carried out. During the first phase, each PLATO author carried out for himself most of the activities needed in CBE lesson production. These activities included lesson design, TUTOR programming, providing subject matter knowledge, and lesson validation. These requirements, difficult to meet by even the most experienced educators, were beyond the qualifications of the PLATO authors. As part of an ISD project, however, the authors joined a more integrated and disciplined effort with defined roles and procedures. While they, in fact, designed most of the CBE lessons, their primary responsibility, in the view of the ISD team chief, was to provide TUTOR programming expertise. The details of the ISD curriculum design model are given in several of the reports summarized after the discussion of the ISD phase.

Under ISD management, the service test's orientation was very different from what it had been under TRAB

management. Whereas before the test was attempting to research basic CBE capabilities, the second phase was simply motivated to develop training materials that would be used as part of operational training. Being operationally oriented did not permit the luxury of selecting the most interesting topics to teach via the PLATO system or of determining experimentally how those topics might be most effectively taught. In practical terms, the shift to the production of CBE materials determined that the PLATO authors could no longer play a major role in directing their own work.

Under the new management, CBE lesson production improved markedly. While no good records were kept, the ISD chief estimates lesson production at 100 manhours per student contact hour. Keeping in mind that the PLATO authors produced as much CBE lesson material in six months under the ISD management as they had produced in over 18 months under TRAB management, it is clear that this estimate is at least plausible. The reader must be warned, however, that these estimates are valid only if taken as general comparisons in productivity between the two phases; no careful documentation of lesson production rates for either phase is available.

Finally, the ISD effort has left at Chanute AFB a tangible product. The CBE lessons altered from the first phase's work or developed during the second phase are still being used in operational training at Chanute. Since January, 1975, the CBE lessons required for the SPVC have been used by an average of 350 students per year for approximately 7000 student contact hours. By itself, this outcome is praiseworthy for its contribution to military training as well as for the accumulation of data giving evaluators some insight to the potentials and problems of CBE use in

military technical training. In comparison to the first phase, this accomplishment is all the more impressive for its magnitude and the efficiency of its execution.

Reports Describing the ISD Phase of the Service Test

The following reports and articles discuss various aspects of the Chanute service test from May, 1974, to April, 1975. Here, the title, author and a brief description of the contents of the document are described. Full bibliographical information for each of these publications may be found in the List of References.

An Overview of Chanute Lessons by J. A. Klecka (1977a). An analysis and summary of eight PLATO lessons written during the ISD phase of the service test. The study is based on in-depth reviews of these lessons both in the formative and final stages of development. An indication of general characteristics of ISD PLATO lesssons is given. The study concludes with an assessment of the instructional effectiveness and utilization of the instructional capabilities of these lessons.

Three Aspects of PLATO Use at Chanute AFB by J. A. Klecka (1977b). The first of these chapters describes the implementation of an ISD systems-design, team-authored PLATO lesson production process; the second, the use of the PLATO system for data management, student testing, and other related computer managed instructional uses; the last examines the changes made to the eight PLATO lessons sampled in Klecka (1977a) in order to achieve the validation criterion.

Evaluation of PLATO IV in Vehicle Maintenance Training by B. E. Dallman, P. J. Deleo, P. S. Main, G. C. Gillman (1977). While nominally covering the entire Service Test, this report of about 300 pages deals mostly with the ISD phase. The data accumulated during this phase is presented

and analyzed. Additionally, extensive anecdotal information concerning this phase is distributed throughout the report. To obtain a balanced view of much of the subject matter of this report, its reading should be accompanied by the reading of Misselt et al. (1977).

"A Critique of the Final Evaluation Report of the Computer-based Education Service Test at Chanute AFB" by A. L. Misselt, H. A. Himwich, L. D. Francis, R. A. Avner, K. K. Tatsuoka, and J. A. Klecka (1977). The critique is a close chapter-by-chapter commentary on Dallman et al. (1977). This commentary was written by CERL personnel who acted as evaluation, instructional, and programming consultants for the Chanute CBE service test.

"Military Instructor Attitudes Toward Computer-Based Technical Training" by J. A. Klecka (1977c). The attitudes of Chanute instructors toward the PLATO system in vehicle maintenance training were investigated. It was believed that instructor atttitudes would influence instructor and student acceptance of CBE in the training environment. The attitudes were measured via surveys and interviews with the instructor staff and other related personnel at Chanute over a period of several months. The results gave a basically positive picture of instructor attitudes and their consequent impact on student interaction with the PLATO IV system.

"Attitudes and Performance of Military Students in Computer-Based Technical Training" by K. K. Tatsuoka, A. L. Misselt, and P. L. Maritz (1977). The student attitude data reported by Dallman et al.(1977) are re-analyzed and compared with measures of performance. The results and interpretations differ somewhat from those reported by Dallman et al.

Summary

The ISD phase of the Chanute service test was in many respects a new beginning for the test. Although the staff of PLATO authors remained the same, a new research agreement initiated the phase along with new management, new objectives and a new approach to CBE lesson development. The result was an eight-month effort which was more productive in terms of CBE lesson material written and validated, CBE materials implemented in technical training, and information concerning CBE use in military training than the rest of the four year service test combined. That Dallman et al.(1977) frequently treat the ISD phase of the service test as the service test and devote substantially more than half of the total pages of the final report to it may be taken as a token of the relative importance of the ISD phase.

As Klecka (1977a) points out, the CBE lessons developed during the ISD phase were not exemplary in terms of using the PLATO medium in an effective manner. This fact may be in part accounted for by the fact that, despite extensive experience in curriculum development in more conventional media, the ISD team had little experience with CBE. Moreover, the time constraints that the ISD team were under dictated that elaborate, media-sensitive PLATO lessons were an unessential luxury. Finally, in the development of any instructional materials, the ISD team endeavored to design the materials to teach only what was required and no more. The fact that the ISD PLATO lessons did not represent optimal uses of CBE does not greatly detract from the achievement of actually producing a large body of instructional material. This accomplishment, substantial in itself, is the more impressive within the context of the rest of the service test.

Although it would be perhaps impossible to attribute the relative success of the ISD phase to any one particular cause, it is plausible that one or more of the differences between the TRAB and ISD phases of the project was the source. The major differences are summarized below.

1) An implementation plan governed the ISD phase. The plan, which had the approval of ATC and AFHRL, precisely articulated objectives and means and timelines for achieving them. The TRAB phase, on account of an inability to obtain agreement from ATC and AFHRL, possessed no finally-approved implementation plan.

2) The PLATO authors were directed by an experienced curriculum developer during the ISD phase; during the TRAB phase, the managers were novices in curriculum development, CBE, and management. Again this would seem to be due to casual interest in the service test from AFHRL and ATC.

3) During the ISD phase, CBE materials were developed in accordance with validated instructional development procedures. In the ISD development procedures the PLATO authors filled an important but precisely circumscribed role. Under TRAB management, the PLATO authors were responsible for virtually every facet of CBE lesson development. Moreover, lesson development procedures were left to the discretion of individual authors.

That these differences existed between the two phases is a matter of fact. That one or more of them could explain the striking difference in outcomes between the two phases appears to be a matter of common sense. In addition to common sense, interviews with service test personnel bolster the conclusion that these factors were important in determining the relative success or failure of each phase.

List of References

Air Force Human Resources Laboratory. Training research agreement entitled "Service test of PLATO IV computer based educational system." Lowry AFB, Col., June 30, 1972.

Air Force Human Resources Laboratory. Training research agreement entitled "Service test of PLATO IV computer based educational system." Lowry AFB, Col., June 1, 1974 (date uncertain).

Dal'man, B., DeLeo, P., Main, P., and Gillman, D. Evaluation of PLATO IV in vehicle maintenance training. TRAB: USAF School of Applied Aerospace Sciences, Chanute AFB, Illinois, 1977.

Descartes, R. [Discourse on the method] (E. S. Haldane & G.R.T. Ross, trans.). New York: Dover, 1931. (Translation originally published, 1911.) (Originally published, 1637.)

Francis, L.D. PLATO IV terminal peripheral devices. Urbana, Ill.: University of Illinois, Computer-based Education Research Laboratory, 1976.

Gissing, R. CAI management plan for special purpose vehicle courses. Chanute AFB, Ill.: June 7, 1974.

Green, J.S. One-year interim report of the AFHRL/ATC PLATO IV service test, 1972-1973 (Report 73-622). Chanute AFB, Ill.: Department of the Air Force, USAF School of Applied Aerospace Sciences, 3 September 1973.

Green, J.S. PLATO project problem documentation. Chanute AFB, Ill.: USAF School of Applied Aerospace Sciences, Training Research Applications Branch, 28 November 1972.

Green, J.S., Main, P.S., & Pennell, R. PLATO IV service test plan (draft). Chanute AFB, Ill., May 1973.

Klecka, J.A. An overview of Chanute lessons, MTC report #10. Urbana, Ill.: University of Illinois, Computer-based Education Research Laboratory, January 1977a.

Klecka, J.A. Three aspects of PLATO use at Chanute AFB, MTC report #11. Urbana, Ill.: University of Illinois, Computer-based Education Research Laboratory, 1977b.

Klecka, J.A. Military instructor attitudes toward computer-based technical training. In A.L. Misselt (Ed.), User attitudes toward CBE in a military technical training setting. In preparation, 1977c.

Main, P.S. "Comments on PLATO IV service test." Memo from Chief, Training Research Applications Branch, USAF School of Applied Aerospace Sciences to AFHRL/TT, Lowry AFB, Col., 5 January 1973.

Main, P.S. "Comments on the draft evaluation plan for Chanute/PLATO service test." Memo from Chief, Training Research Applications Branch, USAF School of Applied Aerospace Sciences to AFHRL/TT, Lowry AFB, Col., 26 February 1973.

Main, P.S. Phase III PLATO IV Evaluations. Lackland AFB, Tex.: Technology Applications Center, Air Training Command, 1977.

Misselt, A.L., Himwich, H.A., Francis, L.D., Avner, R.A., Tatsuoka, K.K., & Klecka, J.A. A critique of the final evaluation report of the computer-based education service test at Chanute AFB. In H.A. Himwich (Ed.), Critique and summary of the Chanute AFB CBE project. In preparation, 1977.

Pennell, R., & Gant, C. Evaluation plan for Chanute/PLATO service test (draft). Lowry AFB, Col.: Air Force Human Resources Lab, 8 February 1973.

Tatsuoka, K.K., Misselt, A.L., & Maritz, P.L. "Attitudes and performance of military students in computer-based technical training. In A. L. Misselt (Ed.), User attitudes toward CBE in a military technical training setting. In preparation, 1977.

Whalen, G.V. "Request for training research." Memo from Chief, Training Research Applications Branch, Chanute AFB, Ill., 14 April 1972.

A CRITIQUE OF THE FINAL EVALUATION REPORT OF THE COMPUTER-BASED EDUCATION SERVICE TEST AT CHANUTE AFB

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Foreword

The following comments partially fulfill a contractual obligation between the Defense Advanced Research Projects Agency (ARPA) and the Computer-based Education Research Laboratory of the University of Illinois (CERL) to provide a critique of reports produced at the various PLATO sites supported by ARPA. The comments supplement the communications exchanged between Chanute AFB and CERL during the course of a long and close working relationship. They are intended to give the reader a view of the project in the context of the general problem of implementation of new instructional technology as well as providing independent comments on historical and procedural matters. The comments are based on the experience of the CERL staff in aiding the implementation and operation of over 20 military Computer Based Education (CBE) sites, as well as professional expertise in the areas of military instruction, instructional design, and evaluation.

We were able to prepare this critique because the Air Force Human Resources Laboratory (AFHRL) staff kindly made their report available to us in draft form. Unfortunately, contract completion dates are such that publication of this critique must be made before the final version of the AFHRL report (Dallman, DeLeo, Main, & Gillman, 1977) will be available. While knowing that the comments we and other reviewers have made may affect the final contents of the AFHRL report, time requirements have forced us to base our remarks on the draft version available in April, 1977. Therefore, readers may expect to find that some problems or questions which our critique raises have been corrected or answered in the final version.

The organization of this critique parallels that of the report; comments are offered section-by-section. In writing the critique, we have made the assumption that the reader has a copy of the AFHRL report in hand in order to follow the commentary; we have provided only a brief restatement of the procedures and findings on each topic. To facilitate references to the AFHRL report, the term "chapter" is used to denote the major sections identified by Roman numerals.

We have found the AFHRL report to be well-organized and informative. It is an important contribution to the literature on CBE and on the implementation of curricular innovations. All of those who assisted in the implementation and reporting of the Chanute CBE project have shown commendable effort and professional expertise in meeting the problems of testing new technology in a realistic training environment.

I. INTRODUCTION

Project Genesis

The section titled "Project Genesis" is a brief but accurate summary of the origins of the service test at Chanute. It should be noted, however, that in addition to stating the broad objectives for the service test, the ARPA/AFHRL/ATC research agreement (cited in this section) also outlined an implementation plan for achieving those objectives. It called for the development of computer-based instructional materials on the PLATO system which would duplicate the content of Chanute's General Purpose Vehicle Course (GPVC). With identical content for that course available in both computer-based and conventionally-delivered modes, it would have been possible to conduct a comparison of the two media categories. Under that plan the conventional course would have provided a standard against which the "cost effectiveness, acceptance, incorporability (into ongoing technical training), and reliability" could be investigated. For reasons described later in the report and in this critique, that initial plan proved to be infeasible.

Responsibilities

The delineation of responsibilities for AFHRL and ARPA provides a concise description of their roles. However, the role of the Training Research Applications Branch (TRAB) is characterized in the original Research Training Agreement as the

> "Technical School OPR [Office of Primary Responsibility] for coordination of the experimental service test with ATC/XPT, AFHRL, ARPA, and the University of Illinois. This office will monitor the research program by developing a programmed action directive for the duration of the three-year research agreement."

While the full intent of this statement is not altogether clear, it seems to imply a somewhat larger role than the responsibility ascribed to the TRAB in Chapter I, i.e., "to evaluate and document the project outcomes".

The difficulty in describing the TRAB's role is that the Chanute service test actually consisted of three distinct "projects", which are referred to throughout the report as "phases". Since each phase had objectives and management unlike that of the others, it is possible to think of them as different projects. The responsibilities outlined in this section of Chapter I are true of the second project or Phase II; they do not necessarily describe the roles taken by the various agencies and units (especially that of the TRAB) during the other phases.

Also, while it is clear that it was ATC's responsibility to provide manpower and facilities, it is apparent from the discussion in Chapter II under the heading "Selecting an Evaluation Paradigm" (as well as the experience of CERL) that ATC had a larger policy-making role.

Project Personnel

Except that it fails to mention the participation of members of the instructional systems development (ISD) team during Phase II, the description of the service test staffing is correct. All of the personnel described in this section did contribute to the project, but they were not all present simultaneously or throughout its duration.

Scope of Development

The development described in this section was that of Phase II of the service test. Phases I and III are described separately in Chapter II.

II. BACKGROUND

PLATO System Description

The description of the PLATO system is brief, but accurate. Readers wishing a more complete background may refer to the article by Smith and Sherwood (1976) or the bibliography by Lyman (1977).

Historical Perspective

Phase I. The discussion of the events of Phase I is a highly abbreviated description of the activities and decisions of this period. Some additional information is provided in the following comments.

The first implementation plan for the service test (contained in the ARPA/AFHRL/ATC research agreement) called for the comparison of CBE instructional materials with conventional materials already in use in the GPVC. Hence the personnel expected to develop the CBE materials, i.e., the authors, were selected from among the GPVC instructors. As indicated in the AFHRL report, the eight individuals who were selected varied widely in the extent of their teaching experience and knowledge of the subject matter to be taught, and they were uniformly inexperienced with regard to development of CBE materials. They received their initial training in the use of the TUTOR language at CERL in the Fall of 1972. The TUTOR workshop they attended was the first of several conducted by the Military Training Centers (MTC) group of CERL for the ARPA-supported PLATO projects. For a description and evaluation of the MTC TUTOR course, see the report by Francis (1976b).

As indicated by the report authors, the lesson development efforts during Phase I were exploratory and served to allow the Chanute authors to expand their skills and develop

their interests. Compared to Phase II lessons, those written in Phase I exploited system capabilities much further in terms of their wider use of computer-generated questions, individualization via feedback and branching, and animated graphics. Each of the Phase I lessons was considered by the staff to be a mini-experiment in CBE; each was thought to investigate the use of one or more of the features described above. Developed by persons with little or no experience in instructional design or CBE, these lessons were written with idiosyncratic instructional strategies and often failed to represent the educational concept or CBE feature they were designed to investigate. If the reader keeps in mind the statement in the report that "Each author became an investigator in his own right", and the fact that these authors were highly inexperienced, one can easily construct an image of the resulting lessons. Nevertheless, experience was gained in the areas of lesson design and programming and a number of lessons were developed, many of which were later modified for use in operational training during Phase II.

There were a number of problems and frustrations during Phase I which hampered the productivity of the project. In addition to the constraints mentioned by the report authors (e.g., delays in equipment delivery, computer memory shortages, system unreliability, changes in and lack of documentation of the TUTOR language), there were several management and environmental problems which interfered with the goals of the service test. These included the lack of commitment on the part of certain operationally-oriented personnel to the test's exploratory nature, turnover and inexperience among management personnel, and the lack of an approved implementation plan. These latter problems are discussed in detail in the chapter by Himwich (1977a).

By early 1974 it was apparent that the CBE lessons developed to replace selected classroom lectures in the GPVC did not represent the most effective application of the PLATO medium. This, plus the fact that student flow through the GPVC was to drop drastically, led to a suggestion that CBE be implemented in the common area of four Special Purpose Vehicle Courses (SPVC). Not only was it hoped that the existing GPVC lessons could be utilized in the SPVC, it would also be possible to take advantage of the larger student flow for a full program of lesson validation and program evaluation. Finally, since the SPV courses were about to undergo a systematic revision, it would be a simple matter to integrate PLATO as a primary instructional medium, hence simplifying many implementation and evaluation problems.

The suggestion to shift CBE development to the SPVC was put in the form of a proposal and submitted to ATC and AFHRL for approval. This approval was granted following a formal project review in May 1974. However, more than just a shift in target courses was decided. There was also a shift in the general orientation of the project from an exploratory research focus to one of integrating PLATO into operational training. This was to be accomplished by assigning the authoring staff to the supervision of the 3340th Technical Training Group's ISD team. The May 1974 project review marked the transition from Phase I to Phase II and hence was an important turning point in the test's history.

Additional data on Phase I, the first 22 months of the service test, would have been useful. Some data are presented in the chapter by Himwich (1977a). Also, several project reports exist which supply some of these data. The most useful of these is the report by Green (1973). It gives a detailed description of the authors selected, an extended discussion of early management problems of the service test

and a summary of the early lesson development efforts of the authors. An interesting contribution of Green's report is its tracking of author attitudes and morale through early service test events.

Phase II. This section gives a brief overview of some of the activities and outcomes of the service test's second phase. The brevity is justified because most of the discussion in the remainder of the AFHRL report is devoted to data collected during Phase II.

Phase III. A third phase of the test was originally conceived as a way to utilize surplus authoring time available during the validation period for the Phase II lessons. The contract period with ARPA ended on September 30, 1975, but was extended until June 30, 1976, to allow time for further analysis of Phase II evaluation data and the completion of the Phase III studies. The revised management plan under which Phase III was begun was thought by CBE experts from CERL to be overly ambitious though feasible in its main intent. The management of this portion of the project was as unstructured as that of Phase I, but the exodus of trained PLATO authors was itself sufficient to make the objectives unattainable. A detailed summary of the staffing problems of the service test may be found in the chapter by Himwich (1977a).

Although never officially described as such, a fourth service test phase was funded by ATC. Running from July 1, 1976, to September 30, 1976, it was intended to allow additional time to collect data on the cost saving contributions of the PLATO system to the operation of the SPVC. Specifically, the goals of this follow-on effort were to determine the time savings due directly to PLATO (i.e., above and beyond those due to group-pacing), to determine the benefit from on-line testing, and to determine the max-

imum student load that could be handled with Chanute's complement of 30 PLATO IV terminals. To answer this last question, the SPVC lessons were used as replacements for a number of the lectures in the GPVC in order to increase the total student flow through the materials. The results of these "Phase IV" studies are reported in an unpublished manuscript prepared by the former chief of Chanute's Training Research Applications Branch. These results are not discussed in the AFHRL report.

Instructional Setting

The "instructional setting" section of the report deals with the relationship among the four target courses, the manner in which the courses were changed as a result of the ISD team's redesign of the curriculum, the basic student performance indices that were measured, and the general nature of the material selected for CBE development. This information is fundamental to an understanding of the Phase II effort and, considering the small amount of space allotted, it is presented with admirable clarity. To facilitate interpretation of later sections, a few of the more important points deserve special attention. They are highlighted in the following comments.

One of the most basic changes resulting from the ISD redesign of the courses is that classes progressed through the revised versions at the rate of their slowest members (i.e., group-pacing was used). If a class were heterogeneous in previous background and learning rate (the usual case since homogeneous grouping was not attempted), the faster students were assigned supplemental material to keep them occupied. Thus, the change to group-pacing allowed more flexible scheduling than was possible in the conventional courses, but it did not provide optimum pacing for all stu-

dents. An individually self-paced system would have been ideal, but according to interviews with Chanute AFB personnel, such an approach could not be implemented because of a shortage of laboratory equipment and because the bulk of the instruction in the specialty shreds was presented via lectures. To develop individualized instruction to replace the lectures was thought to have required more effort than could be justified by the relatively small student flow through the individual shreds and the expense of the additional laboratory equipment that would be needed.

Another change affecting the instructional efficiency of the revised common course segment relative to that of the conventional version was the introduction of the "Block X" concept. The effective length of the courses was shortened by assigning a number of topics to be studied individually as homework. It is our understanding that much of this material had been presented during class time for the "conventional" common course segment. In comparing the two versions, therefore, it should be noted that the revised segment had less content than did the conventional version.

The reversal in proportions of time spent on "knowledge" and laboratory tasks was due both to decreased emphasis on the knowledge areas and an increased emphasis on the performance skills taught in the courses. These shifts in emphasis came as a result of the job analysis conducted by the ISD team as the initial step in development. A second factor was that the lock-step pacing in the conventional version had allowed more "slack" in the scheduling of the knowledge areas than in the laboratory activities. Hence, there was more time to be saved through group-pacing in the cognitive portions.

Another item that should be noted is that the content of the block exams for the revised common course segment differed from those used in the conventional version. Because

of shifting emphases in the content of the first four blocks of the courses, the block exams used in the conventional version were not valid for use in the revised segment. It is not possible, therefore, to compare directly the block exam performance between students taking the conventional and revised versions. Although the tests generally measure similar topics, their coverage is sufficiently different to keep them from being parallel.

This section of the AFHRL report gives only a brief description of the CBE lessons produced during Phase II. A more thorough presentation is available in the report by Klecka (1977a) which gives a detailed discussion of eight Phase II lessons selected by an AFHRL evaluator. Each lesson was reviewed in depth and the resulting comments were synthesized to give an overall description and assessment of the lessons reviewed. The Klecka report was used as a resource and database for Chapter VI of the AFHRL report.

Selecting an Evaluation Paradigm

It is commendable that those who planned the AFHRL evaluation systematically attempted to collect data on the information needs and priorities of the several agencies connected with the Chanute service test (i.e., the various audiences for the evaluation report). The result of this effort was the assigning of highest priority to those areas of greatest interest to ATC, the agency which would have to make decisions regarding support for future applications of CBE in Air Force training.

In view of ATC's requirements for data on which to base decisions, the evaluators chose to conduct a comparative evaluation rather than a more generalizable "evaluation-as-research" approach as might be suggested by Cronbach (1963). A comparative evaluation usually seeks to provide data for

selection of one of the specific products being evaluated, but confounding of subject-matter, student population, and instructional design variables with the media used for instruction would limit the generalizability of a single comparative study. Recognizing these problems, the authors of the AFHRL report have made an effort to identify them for the reader and to provide sufficient information so that their findings can be combined with results obtained elsewhere. By providing ample description of the constraints under which the data were collected, the authors enable interested readers to draw upon these results and others to state generalizations and hypotheses for further investigation.

Although no explicit rationale is given for including the summary of CBE effectiveness studies, it is apparent that one purpose is to highlight an issue in evaluation design found in several of the studies cited. Namely, when CBE or other self-paced media are compared with conventional classroom presentations, the time savings typically enjoyed by the CBE groups can not be attributed entirely to the effects of CBE. Such savings might be due merely to the fact that self-pacing or group-pacing has been employed rather than to any unique CBE characteristics. Since CBE was to be compared with a conventional lock-stepped presentation format in the Chanute service test, the question of how to isolate CBE's unique contribution was an important one in the selection of an evaluation paradigm. Two studies were cited in which this problem was solved by comparing the CBE materials with comparable materials presented by other self-paced media. This type of control was attempted for a few lessons in the Chanute service test (see section on PLATO system effectiveness in Chapter III), but the lack of non-CBE (i.e., off-line) self-paced materials made it impossible to implement on a larger scale.

Another apparent reason for citing CBE effectiveness studies was to summarize their findings as background for the results obtained in the Chanute service test. A study of particular interest was that conducted by the U. S. Army Ordnance Center and School (Dept of the Army, 1975). It involved a comparison of the time required to achieve a preset criterion of mastery for each of a series of CBE lessons and for a parallel series of lessons presented on conventional self-paced media. The project staff reported time savings in favor of CBE in most of the lesson-by-lesson comparisons (Dept of the Army, 1975, p. C-4), but an independent examination of the data and analysis procedures revealed difficulties that make some of the results equivocal (Avner and Misselt, 1977). Avner and Misselt do conclude, however, that the Army project's conclusions with regard to educational effectiveness of CBE are generally supported by the available data. Related reports by Himwich (1977b) and Call-Himwich (1977) discuss the implementation and management of the Army project and give a critical appraisal of the CBE lessons that were developed.

Overall Methodology

Conditions. The description of the training conditions or "treatments" which were established for comparison purposes is factually correct although it may be too brief to give a clear understanding of the way in which they were implemented. It is important to emphasize that the ISD revision of the four Special Purpose Vehicle courses (i.e., the shreds) included not only the first four blocks common to all shreds (termed the common course segment) but also the remaining blocks of each shred. The revisions to the common course segment were more extensive in that all lectures were replaced by PLATO lessons and other self-paced media, but the

contents of the "shred areas" (i.e., the blocks of each course following the common course segment) were also changed to reflect the revised course goals (established by the ISD team in their analysis of job requirements). The only use of PLATO in the shred areas was in the administration and scoring of block exams; no CBE lessons were used.

The revision of the shred areas was conducted concurrently with that of the common course segment. The B shred revision was completed first (note that according to Figure 2 in Chapter II, the B shred had the fewest blocks) so operational trials of the revised version could begin 15 Jan 1975. The D shred revision was the next to be completed with the first trial class starting on 13 March 1975. The C shred was ready for its first class by 22 May 1975, while the A shred (the longest according to Figure 2) was not completely revised until 13 June 1975.

It was this staggered completion schedule that defined the treatment conditions. Because the A shred revision was the last to be completed, classes entering that course between January and June of 1975 were given the conventional version of the curriculum. These classes were the only ones assigned to the NP (conventional) condition. Classes entering the C and D shreds between January 1975 and the time that the shred area revisions were complete were assigned to the CP condition. The PB condition was made up of the B shred classes and those classes entering the other shreds after their respective revisions had been completed. The BL condition included classes from all four shreds which, of course, received conventional training during the common course segment as well as the shred areas.

Because of the confounding between shred assignment and condition (e.g., NP consisted only of A shred students), interpretation of the results rests on the assumption that

there were no consistent differences among the shreds in terms of student aptitude, teaching ability of instructors, and other factors likely to affect performance. The fact that the treatment conditions were defined in this way, rather than by random assignment or some other form of control, is a threat to the internal validity of the design (Campbell & Stanley, 1963). However, it exemplifies the kind of compromise between the requirements of research and those of operational and logistic concerns that, unfortunately, must be made when an operational orientation is paramount.

Student population. As indicated by the authors, the differing sample sizes were due entirely to the staggered implementation of the ISD revisions to the various shreds. This is one area in which the constraints placed on the evaluation by the operational orientation of the service test were particularly severe. If it had been possible for the evaluators to control the rate of implementation, more uniform sample sizes could have been obtained.

In general, overall sample sizes are judged to be sufficient to provide statistical tests of sufficient power to detect the major effects likely to be of interest in instructional settings. Detailed power analyses are given for individual comparisons later in this critique. The probability of detecting true differences of at least one standard deviation between means for the major groups (PB,CP,NP, and BL) was at least .95 (for an alpha level of .05). The prrobability of detecting smaller differences likely to be of research interest is, however, quite small (no higher than .56 for any comparison involving the NP group in detecting a true difference of at least .5 standard deviations, again with alpha of .05).

III. INSTRUCTIONAL EFFECTIVENESS

When the agencies most closely involved with the service test were surveyed regarding their priorities for the evaluation, the question of instructional effectiveness was seen to be of prime importance. It is not an easy question to answer--given the constraints arising from the "operational" orientation of Phase II--but those persons responsible for the evaluation have demonstrated considerable resourcefulness in dealing with the problem. Chapter III gives a well organized and informative account of the various data collection procedures and analyses used in addressing the instructional effectiveness issue.

Special Purpose Vehicle Course

Special purpose vehicle course procedures. This section gives a concise description of the variables measured and the procedures used in data collection. No further comment is needed.

Block exam scores. As mentioned in an earlier section of this critique, the block exams in the common course segment and the shred areas had to be revised to reflect scope and depth-of-content changes resulting from the ISD effort. Once the revised courses were fully implemented, all students received the same instruction during the four blocks of the common course segment and were tested using the revised block exams. During the period when the evaluation data were collected, however, only the students in the PB condition were given the revised exams--students in the NP and CP conditions took the original (unrevised) versions. It is for this reason that the PB condition could not be included in the analyses of variance summarized in Table 3.

A comment is in order regarding the use of ANOVA to perform separate univariate analyses for each of the four block exams. Unless the variables (e.g., the block exams) are independent of each other, it is inadvisable to conduct separate univariate hypotheses tests for each of several variables measured on the same set of subjects. Another possible analysis in such cases is multivariate analysis of variance (MANOVA) (see Tatsuoka, 1971). If the comparisons had been independent and if group sizes had been roughly equal (with the same total sample size), the tests would have had the power to detect a moderate effect (one accounting for 5.88% of population variance) with probability of at least .96.

A final comment on the reporting of the block exam results is that no information regarding the reliabilities of these exams is provided. At a minimum, it would have been useful to have reported the number of items on each exam along with the means and standard deviations given in Table 2. With this additional information, it would be possible to estimate test reliability using the KR-21 estimator.

Course completion time. The rate at which students complete the course is an important variable in assessing the efficiency of the ISD revisions, but it does not directly measure their effectiveness. Presumably it is an indirect measure, however, because students would not progress from block to block if their instruction were so ineffective as to prevent them from passing the block exams.

Time savings due to the course revisions were computed by comparing mean completion times under the revised course with the baseline completion times under the original course. Comparisons were made within each shred for the common course segment (which included PLATO instruction) and for the shred taken as a whole (i.e., including the shred area blocks).

It is apparent from Table 4 in the AFHRL report that time was saved in each of the common course segment blocks, but that some shred area blocks took longer to complete under the ISD revision than under the baseline version. This latter observation reflects the ISD redistribution of course content in some of the shred area blocks--some blocks were shortened while others were lengthened.

Table 5 in the report presents the mean hours saved per block and the percentage of the baseline completion time that was saved in each shred during the common course segment. It is stated in the text of the report that 28.5% of the common course segment baseline time was saved in the ISD revision. It should be recalled from earlier discussion that some of this time savings is due to moving some content items to Block X (home study) and much of the remainder is due to the introduction of group-pacing to replace lock-step pacing. It may also be that the use of PLATO contributed to this overall time savings by saving some time above and beyond that expected by delivering the same instruction with other self-paced media. Additional discussion of this point is given in Chapter IV.

Eliminations. It was reasonable to plan to examine the frequency of academic eliminations in the various treatment conditions, but, as stated, there were so few eliminations during the evaluation period that analysis was unnecessary.

Washbacks. No further comment is needed.

Absenteeism. The number of absences is another of the course parameters which is easily measured and which permits comparisons among the various conditions. Its relevance to the question of instructional effectiveness is not clear, however, as it seems to be more of a measure of motivation than a measure of learning. As such, it might more appropriately have been discussed in Chapter V along with the other indices of instructional impact.

The absentee data were analyzed by the Chi square test for independence. The total number of absences and the mean number of non-absences were compared across conditions in a series of two-way classification tables. Unfortunately, the discussion of how the mean number of non-absences was computed is given in too little detail for us to evaluate its logic. Without additional information, we are unable to verify the correctness of the procedure or the accuracy of the results.

Regardless of the outcomes of the analyses of absentee frequencies, the supplemental ANOVA on number of hours absent seems to have been conducted appropriately. No significant differences among the conditions were found on this measure.

Special individualized assistance. While the extended median test is applicable in the case described, use of Scheffé's multiple-comparisons approach would have permitted the post hoc conclusion (that the CP students were given more assistance) to have been made explicitly rather than as a qualitative observation.

Field evaluation. The first observation likely to be made in a careful reading of this section is that there is a discrepancy between the number of NP students purportedly studied in the field evaluation (28) and the sample size reported for earlier analyses (21). It is our understanding that several students who were trained under the NP condition were omitted from earlier analyses because of incomplete data. Missing data on other variables should have no bearing on field evaluation analyses, however, so it seems appropriate that these students have been included in the NP sample.

The discussion of the analyses of the field evaluation ratings data is fairly complete, and the analyses seem appropriate for the available data. The major finding was that there were no significant differences among the conditions

with regard to the overall performance ratings and a derived score based on the ratings for the 33 individual target tasks. A supplemental analysis showed that supervisor ratings on four of these tasks were significantly related to the overall performance rating for those students whose duty assignments were at the apprentice level.

Discussion of course effectiveness. The discussion in this section addresses the question of whether or not the two PLATO-using treatment conditions (PB and CP) were instructionally effective. The premise on which the arguments seem to be based is that the PB and CP conditions should be considered to be "effective" if they fare as well as the NP and BL conditions on the various indices of course effectiveness that were reported. Accepting this premise assumes that such measures as number of washbacks, rate of absenteeism, hours of SIA time, and instructor ratings in the field are adequate indicators of effectiveness. While most of these measures are valid for the desired purpose, many of them are insensitive (in comparison to tests) and are of limited value in discriminating among treatment conditions. Because the PB common course segment block exams were different from those taken by the other groups, they could not be used for comparative purposes. Fortunately, the CP group took the same block exams as did the NP and BL groups so that a more sensitive measure of CP condition effectiveness was available.

Inferring from the pattern of results on the set of relatively insensitive indicators described above, the authors concluded that the PB condition was at least as effective as the NP and BL conditions. Likewise, they concluded that the CP condition was "effective"--according to the criterion described above--because it fared as well on the various measures (including the block exams) as did the NP and BL conditions.

Although the discussion in this section of the report appears to us to be accurate, it suffers from lack of clarity. Furthermore, the arguments do not seem convincing. We believe that much of this problem stems from the fact that the authors chose not to present the results found with another measure--the special topical test. Because we feel it provides additional insight into the question of course effectiveness, we wish to supplement the AFHRL report by discussing this test and the results obtained with its use. We have had access to this information due to our role as data analysts in assisting with the service test.

A special topical test was constructed by the service test evaluation team for the purpose of attempting to isolate the effects of the PLATO system from those of the other changes made during the ISD redesign of the curriculum. This topical test--mentioned briefly in the report under the heading "PLATO System Effectiveness"--consisted of 30 items testing material covered in the CBE lessons and 20 items over topics presented by other media. The original intent of the evaluators was to compare the various treatment groups on the basis of scores for each of these two sets of items (i.e., a PLATO item score and a non-PLATO item score). Presumably, it would be possible to determine from these comparisons whether PLATO had effects above and beyond those of the other "ISD influences". Because of excessive item difficulty and other technical problems, however, the PLATO item and non-PLATO item sub-scores were highly unreliable (coefficient alpha reliabilities of .55 and .38, respectively) and these results were not reported (see section on "PLATO System Effectiveness").

While it is appropriate that the sub-score results were omitted from the report, a second set of analyses based on the somewhat more reliable total scores (i.e., the sum of the

PLATO and non-PLATO item sub-scores) gives valuable information on the question of course effectiveness, the question addressed in this section. The reliability of the total scores falls short of what would be desirable for most purposes (coefficient alpha = .65), but, if interpreted cautiously, the results can be used as a check on findings obtained with other measures.

The special topical test was actually administered three times during the flow of the course--once as a pretest, once at the conclusion of the common course segment (posttest 1), and once at the end of instruction in the shred areas (posttest 2). It had been planned by the evaluation team to compare the treatment groups at each of these three points in time, but for the present purpose it is sufficient to consider only the pretest and posttest 1.

There were no significant differences among the groups on the pretest ($F(2,145)=.434$, $p=.649$), an indication that they were homogeneous with regard to initial knowledge of the topics covered. As can be seen from Table 1 (in this critique), the NP group had the smallest mean performance on posttest 1.

Table 1
Group Means and Standard Deviations
on Posttest 1 Total Scores

Group	Mean	Standard Deviation	n
PB	28.111	4.696	81
CP	28.727	5.398	44
NP	23.565	4.998	23

A one-way fixed-effects ANOVA on posttest 1 total scores is summarized in Table 2. The effect underlying the significant F statistic accounts for 11.2% of total sample variance. The power of this test to detect an effect of moderate size (accounting for 5.88% of population variance) is only about .76, so a smaller effect might easily have missed detection. Post hoc analyses using the Scheffé method show the PB group performance to be significantly higher than that of the NP group ($p = .001$). The CP group also had significantly higher scores than the NP students ($p < .0005$), but the difference between the PB and CP groups was not significant ($p = .803$) and is most likely due to chance effects.

Table 2
Summary of ANOVA on Posttest 1 Total Scores

Source	df	MS	F	p
trtmnt	2	225.741	9.177	.0002
error	145	24.598	--	--

The special topical test results seem to indicate that the ISD-revised course taken by the PB students was more effective than the original instruction on these topics. The fact that the CP group also fared well relative to the NP group is due to the combined effects of the CBE materials and supplementary discussions/review provided by the instructors. It is interesting that this supplemental instruction did not raise the scores of the CP students significantly above those of the PB group even though more training time was expended (see Table 4 in the report). It should be remembered that coefficient alpha for the special topical test was only .65, but, on the other hand, the major effect of unreliability in

ANOVA is to obscure the differences among treatments by reducing statistical power (for a discussion of this point, see Cochran, 1968; Misselt, 1977). It is important that significant differences were found in spite of such unreliability. Although there may be other confounding factors (e.g., differing levels of experience/effectiveness among intructors for the various conditions) which could account for these results, they seem to add direct support for the conclusion drawn in the report itself that the PLATO-using conditions were "at least" as instructionally effective as the non-PLATO versions.

In addition to the authors' decision to base their discussion of course effectiveness on what we consider to be relatively insensitive measures, another problem detracting from the clarity of the presentation is their tendency to intersperse discussion of "efficiency" issues within the context of the "effectiveness" question. It is desirable to compare the efficiency of the various treatment conditions but it is important not to confuse measures of efficiency (e.g., the completion time required in the various blocks) with those of effectiveness. With regard to instructional efficiency, there is ample evidence that the revisions did reduce training time. This, after all, was the major goal of the ISD team. They did not set out to teach more content or teach to a higher degree of mastery. Instead, they attempted to make the common course segment instruction more efficient. They apparently were successful in this effort.

PLATO System Effectiveness

Procedures. The evaluation team attempted two procedures for assessing the effectiveness of the PLATO system (as used at Chanute) apart from the effects of other important variables in the environment. The first of these, mentioned

only briefly in the report, was a plan to use the sub-scores on the special topical test to look for differences in learning between the treatment groups on two sets of topics--those covered by PLATO lessons and those taught using more conventional media. Any differences among the groups on the non-PLATO item sub-scores presumably were to be taken as evidence of differential effectiveness between the revisions and the original instruction on these topics. If, for example, the PB group were to do no better than the NP group on the non-PLATO item subtest, it would have been an indication that the ISD procedural changes inherent in the PB condition had no special effect. If, meanwhile, the PB group had done significantly better than the NP group on the PLATO item subtest, it would have been taken as evidence that Chanute's use of PLATO had effects above and beyond those of the remaining ISD influences. This plan was not implemented because of the low reliability of the sub-scores (see discussion in the previous section of this critique). However, even if the tests had been more carefully developed so as to have adequate reliability, it is not immediately clear that it would have been possible to separate the effects of PLATO from those of the other environmental changes using the plan outlined above.

The second procedure used in attempting to determine the effects of the PLATO system (i.e., while controlling other variables) was a special comparison between a group studying four of the PLATO lessons and a group given four programmed texts over the same set of topics. Because the programmed texts used electrostatic copies of screen displays (or frames) from the PLATO lessons, the extraneous effects of subject matter and lesson strategy were controlled (Salomon & Clark, 1977). The comparisons were based on end-of-lesson test scores and the time required to complete the lessons. The students studying the programmed text versions were also

asked to state their preference between programmed texts and PLATO (they had used PLATO to study other topics).
The discussion of these procedures is clear and concise, but it would have been useful to add some description of the data collection procedures and some assessment of the reliability of the measures used (including the completion time measurements).

Results. No significant differences in lesson test performance were found between the PLATO and Programmed Text (PT) comparison groups. One concern to be noted is that the tests used were originally designed to be criterion referenced tests. Because criterion referenced tests tend to give a "ceiling" effect and have low variances, they are generally not very suitable for comparison purposes (Popham, 1971). Even so, a more senstitive measure could have been obtained by summing the item scores on the four lesson tests to give a single overall score.

In the absence of information about the reliability of the completion time data, little can be said about the results obtained. It is important, of course, that the PLATO group had fewer individual failures and that the PT group indicated a preference to studying lessons on PLATO.

Discussion of comparison findings. The discussion in this section is carefully reasoned and accurate. The conclusion that the PLATO lessons were more instructionally effective than their PT counterparts seems justified by the data presented. The caution about overgeneralization of these results is an appropriate one, however.

PLATO Courseware

Procedures. As indicated by the report authors, there were insufficient resources to develop parallel non-PLATO instruction on each of the topics targeted for CBE. Since no

other lesson materials covering the appropriate content were available, it was impossible to do a comparative evaluation on a lesson-by-lesson basis. The alternative was to determine the extent to which each lesson was capable of bringing students to a pre-determined level of performance.

Once a lesson was shown to have been effective instruction for a suitable validation sample, it was said to be "validated". The proportion of students passing each lesson's Master Validation Exam (MVE) was monitored continuously during the evaluation of Phase II. When a validation attempt failed (i.e., more than 10% of a 20-30 student sample failed to pass the MVE), the lesson was revised in the hope of making it more effective. Once a validation attempt was successful, no more revisions were made (this procedure was based on the premise that lessons should be developed as "lean" as possible initially, then making only those additions which are necessary for them to validate).

A check on the "appropriateness" of the decision to consider a lesson as having validated was made by monitoring "post validation" failure rates. If the failure rate was too high (greater than 20%), the lesson was to be revised and subjected to new validation trials. Failure rates between 10 and 20% were an indication that a lesson should be monitored carefully. Only if no more than 10% of the post validation students failed the MVE was the lesson considered to be instructionally stable.

Results. The fact that four lessons definitely needed revision and eight others may have needed to be reworked indicates that the original validation criterion was too lenient. That a systematic validation procedure was followed at all is certainly commendable, but the procedure used seems arbitrary and intuitively based. A more scientific validation procedure has been developed by Tatsuoka (1977). It

applies a Bayesian statistical model to the data from a validation attempt and derives an estimate of the probability that the lesson will "remain" validated in the population from which the initial sample was drawn. It was possible with this procedure to predict which lessons would be most likely to "de-validate" over time. The data given in the AFHRL report confirm these predictions. A comparison of Chanute's validation approach and the proposed alternative is given in the report by Tatsuoka (1977). Tatsuoka's report also discusses the shortcomings of defining "validation" in terms of test scores; a poorly-constructed test may not be an adequate instrument for judging the effectiveness of a lesson. There is a need for establishing a better validation criterion.

The analysis of on-line time data is probably more relevant to the topic of instructional efficiency than it is to instructional effectiveness. In any event, however, the statement that further time savings could be realized from a self-paced course structure is quite justified.

Discussion of lesson performance results. The discussion in this section is well-stated and complete. No further comments are needed.

Instructional Effectiveness Conclusions

The major conclusion regarding effectiveness is that the PLATO lessons and other materials and procedures introduced in the new course led to adequate student learning. We believe the available data supports this conclusion.

A second conclusion is that the revised course is more efficient because it requires less training time to complete. Part of this time savings may be due to such things as depth-of-instruction changes, moving some of the material from the common course segment to the shred areas or to Block X (i.e.,

home study), and the change to a group-paced format. It is not possible, therefore, to attribute all of the time savings to more efficient teaching strategies or the standardization of instruction, but it is likely that these account for some of the efficiency advantages.

IV. COST FACTORS

This chapter demonstrates the difficulties of determining true operating costs in realistic operating environments. Actual instructional settings are rarely composed of independent accounting units. Thus it is usually necessary to infer costs as some fraction of a total which includes the expenses of unrelated activities. Experimental operations also are rarely able to make use of the savings that would accrue from saturation-use of delivery facilities. Under experimental conditions, there is a need to provide sufficient unscheduled resources to permit exploitation of research opportunities which are discovered during a project. In a "production" setting, all available resources would be fully utilized with the result that costs would be shared by more users, and cost-per-unit-instruction would be decreased.

Instead of following the headings and format of Chapter IV, in which all costs are separately categorized, this section of the critique converts presentation costs into a single form for ease in gaining an overview.

Using industry standards, costs may be determined on an annual basis by assuming electronics hardware to have a seven year life span, classroom improvements to have a ten year life span, and interest costs to the Government to be 7%. We then find the total capital expenditures of $191,688 have an imputed annual cost of $35,568 per year, the $4,803 spent for facilities preparation have an annual cost of $684, and operational costs are $89,933, for a total annual cost of about $126,185. These figures may also be interpreted as costs per terminal of $4,206 per year (with 30 terminals) or as costs per terminal hour of $3.85 (using the figure of 1092 hours usage per terminal per year cited in Table 20 of the report).

Since less than 1% of the annual cost of terminal operation is a function of operating time (e.g., the cost of electricity for operating the terminal), the cost per hour of a terminal could be lowered substantially by higher utilization rates. The average weekly use of the terminals was less than 25 hours, a figure that could have been doubled with moderate ease in a full-scale training situation. The hourly terminal cost is of interest because it is this figure which determines whether a savings in training time from use of CBE is sufficient to make use of CBE cost-effective.

Based on the estimated student time savings of 1 1/3 training days (or $64) cited in the section on "real savings", time savings would pay for only about 16.6 hours of CBE time when terminals were used for no more than 25 hours per week. If terminal usage were doubled, as suggested by the AFHRL report, the hourly rate per terminal would decrease and the observed time savings would have paid for over 33 hours of terminal time. Since these times bracket the observed student on-line times in the course, it appears that CBE was close to being as cost-effective in this situation as programmed texts. A complete analysis of such a comparison would, of course, be possible only if data for larger-scale implementations of both approaches were available for this situation. Also needed would be more detail on indirect costs associated with use of CBE and alternative media at Chanute. Unfortunately, the basis for many of the cost figures reported in this chapter is not given in sufficient detail to go beyond the analysis given by the authors. Given such added detail, potential savings in instructor time and marginal benefits in increased student-instructor satisfaction could also be evaluated. It is possible that the distributed instructor time-savings described by the authors could be applied to a heavier student load in some situations, for example.

In summary, if the AFHRL estimate of a 10% time savings due to CBE is correct, it appears that the experimental implementation was close to being cost-effective and that the more complete resource utilization possible in a full-scale implementation might be cost-effective even with currently available hardware.

V. INSTRUCTIONAL IMPACT

Chapter V gives an extensive and careful discussion of several issues relating to the incorporability of PLATO in the Air Force technical training environment. It is a very informative and well-organized account. However, for the sake of convenience, our discussion uses a system of headings and sub-headings which is slightly less detailed than that used in the chapter.

Introduction

The rationale for including the study of student and instructor attitudes in the evaluation is quite valid. The attitudes of these two key groups are important indicators of the overall acceptance of an innovation such as CBE; student and instructor acceptance are essential for effective implementation.

Student Attitudes

Short form survey. The similarities and differences between the PLATO and non-PLATO versions of the short form survey and the scoring procedures for both are appropriately described.

Method. The procedures for data collection are described concisely. No further comment is needed.

Results. Given the decision to combine the individual attitud items to form a single scale, the combinations chosen by the authors for the PLATO version and the NP version seem appropriate. The reliabilities of the resulting scales are sufficiently high, however, to suggest that the individual item reliabilities may also be fairly large. If so, combining the item scores into a single scale score may effectively "throw away" some information available in the individual

items. Tatsuoka, Misselt, and Maritz (1977) report a number of analyses of the short form survey response data which treat each [redacted] a separate variable. In a similar vein, the decision by the report authors to base their analyses on a random selection of 20 subjects from each condition does not make full use of the available data. Rather than "throw away" data from the PB and CP conditions, the authors might have used the unweighted means analysis or the least squares solution (Kirk, 1968, pp. 276-282).

The first analysis reported was a comparison of the so-called "PLATO-using" conditions (PB and CP). It used a scale based on a combination of all five short form items and showed a significant drop in attitude as the students progressed through the blocks. The CP group held slightly more favorable attitudes than the PB group, but the difference was not significant. Both groups' attitudes remained positive throughout the course even though they were less positive at the end than they had been at the beginning.

The second analysis also used only 20 subjects per group, but it allowed comparisons among all three conditions on the scale derived from the three media acceptance items. As before, there were no significant differences among the conditions, although the use of the available data would probably have increased the power of the test for this effect and significant differences might have been found.

The summary of open-ended comments is informative and is consistent with our understanding of both the student population and the CBE lessons developed at Chanute.

Discussion. The hypotheses suggested in this section regarding the decline of attitudes over time are reasonable. The authors' hypothesis that student attitudes may have been negatively influenced by technical packaging errors in the CBE lessons (e.g., typing and spelling

errors, nonexistence or inability to access "advertised" branching sequences, execution errors, etc.) is consistent with results found by R. A. Avner (personal communication) in another context. Avner correlated "quality scale" ratings of 23 lessons with student ratings of "helpfulness" for learning the presented material. The quality scale included references to technical errors so severe that they prevented students from completing a lesson, as well as minor typographical errors that were only cosmetically harmful. He found a significant relationship between the two sets of ratings ($r(21)=.923$ with .95 Confidence range of .825 to .967). The Chanute materials contained a number of these technical problems during the data collection period.

It is also plausible that the PLATO-using students were subject to the "Hawthorne effect" during this study. This effect could have caused an initial inflation in their attitudes toward CBE followed by a gradual decrease throughout the course. In any event, the attitudes toward PLATO were more consistently positive than attitudes toward instructors. This consistency may be a real advantage for CBE--especially during periods of mobilization when experienced instructors may be difficult to find.

Long form survey. The description of the survey questionnaire is quite adequate for communicating its essential features.

Method. The factor analysis of the combined PB and CP survey responses is not reported in as much detail as might be useful for independent interpretation. Some additional detail is provided in this critique.

The responses of the 200 PLATO-using students on the 66-item survey were subjected to a principal components analysis and the resulting components were rotated by the varimax method. The five factors that were extracted

accounted for the following percentages of total variation: 30.52, 6.05, 3.95, 3.63, and 3.21. Together they accounted for 47.09 percent of the total sample variation.

The interpretations of the various factors suggested by the authors may be over-simplified in that the factor labels apply properly only to the aggregate of items whose factor loadings are reported in Appendix D; they do not apply so readily when the loadings for the remaining items are examined. The "purity" of interpretation implied by the various factor labels is attained through the expedient of ignoring those items which appear to be in conflict with the chosen interpretation label. To be sure, the items on each factor which are ignored are those which have "low" loadings. The definition of "low", however, differs from one factor to another; the items the authors choose to ignore on some factors actually have higher loadings than those of items which were retained on other factors.

Results. The report authors computed "raw" scale scores on the various factors for each individual by summing scores on those items whose factor loadings are reported in Appendix D. Since the number of items selected for inclusion differs from factor to factor (because of the differing definitions of a cutoff for loading values described above), the raw sums for each factor were divided by the number of items to give scores representing a person's "average" response.

The interpretation of the mean scores for each factor scale (i.e., the discussion of the results in Table 24) seems reasonable, but it is difficult to do an independent interpretation without also being told the scales' standard deviations.

Two sets of comparisons were completed using the mean scale scores described above. The first of these was a

scale-by-scale comparison of the two PLATO-using groups whose data were the basis for the factor analysis. No significant differences were found using a series of independent groups t-tests for the five scales. Given the non-orthogonal nature of the variables, it may have been more appropriate to do a multivariate analysis (e.g., Hotelling's T 2 or MANOVA followed by discriminant analysis) rather than a series of univariate t-tests (see Tatsuoka, 1971).

The second set of analyses was a series of one-way univariate ANOVAs comparing the mean scale scores of the Conventional PLATO (CP), Early PLATO-Based (EPB), and Later PLATO-Based (LPB) students. The distinction between the EPB and LPB students is that the EPB students studied the ISD version of the common course segment before May, 1975, and the LPB classes studied the same materials (except for possible revisions) after May 1975. As was true of the earlier analyses, it would have been preferable to have applied a multivariate technique (e.g., MANOVA) rather than to have done a series of univariate tests with non-orthogonal variables. If an overall multivariate analysis were to give significant results, the exact nature of the group differences could be determined using discriminant analysis. Because of possible interrelatedness of the scale variables, the significant univariate ANOVA result reported by the authors might be an artifact. Even taking this result at face value, it is impossible to interpret without a knowledge of the group standard deviations on the scale for factor 1. It is unfortunate that this information was not reported.

Another analysis of the long form survey data focused on the preferences of the CP and PB groups (the latter including both EPB and LPB classes) for each of the various media used in the course. Mean responses for these groups were compared on an item-by-item basis using t-tests. The items in

question were items III-1 to III-6 in the long form survey (see Appendix C). The earlier comments regarding use of multivariate techniques apply to this set of analyses as well. This caution noted, the only comparisons yielding significant t statistics were those regarding item III-2 (PB students viewed PLATO lessons more favorably than CP students) and item III-5 (CP students were even more favorably disposed toward laboratory instruction than the PB students).

The graphical portrayal of mean responses toward the various media shown in Figure 5 of the AFHRL report is a concise format for conveying the media preferences of the two groups. It would also have been helpful to have indicated the within-group variation in stated preference. At any rate, one of the most striking observations to be made from Figure 5 is that the average vehicle maintenance student has a strong preference for laboratory activities; he would much prefer to work with his hands than to engage in learning activities that are more cognitive in nature.

Items III-7 to III-18 of the long form survey (see Appendix C of the AFHRL report) asked the PLATO-using students to indicate their emotional responses toward the PLATO system as used in their course. The individual t-tests that proved significant and their interpretation are aptly discussed by the authors. Perhaps more interesting than these PB vs. CP comparisons is the graphic representation of the mean response patterns for the two groups shown in Figure 6. It is apparent that the overall response toward PLATO was positive. Information on the group standard deviations for each item would have been helpful in determining the extent to which the reported means are typical of the individual student responses.

The correlational analyses indicating the positive relationship between attitude and perceived reliability of

the system are quite interesting and are consistent with our experience with other PLATO users. It is also interesting to note, however, that the attitudes of these students (regarding perceived reliability as well as other aspects of their experience with PLATO) were not related to their performance on block exams or the special topical test (see Tatsuoka, Misselt & Maritz, 1977). Perhaps one reason interruptions to service did not affect performance is that student learning was controlled by the mastery learning criterion. If a student happened to earn a low score on an end-of-lesson test because of system unreliability during study of that lesson, he was routed back to the lesson's starting point. The mastery criterion served as insurance against ill effects of unreliability as well as those of other factors which may hinder performance. Hence, scores on block tests were not affected by system "crashes". It is not known whether interruptions to service may detract from performance in non-mastery settings.

Discussion. The commentary given by the authors on the attitude results is generally quite reasonable. The conclusion that the automotive maintenance students were very accepting of PLATO as an instructional medium seems to be well justified.

Technical training survey. This section's discussion of the purpose of the technical training survey and its 12 scales is adequate for an understanding of its application in the service test. More complete information on its development and the results of its use in the broader context of Air Force technical training presumably is forthcoming in a separate publication.

Method. No comment is needed.

Results. Sufficient usable data were available to perform 4 x 2 (condition x administration) univariate

repeated measures ANOVAs on eight of the 12 sets of scale scores. Although a multivariate analysis technique might be preferred, the authors' summary of the univariate results is clear and concise. To be more complete, the summary might have included tables of means and standard deviations for each administration to each of the four conditions studied (i.e., BL, NP, PB, and CP).

The comparisons of the automotive maintenance students' attitudes with those of other technical training students at Chanute and within Air Training Command as a whole were conducted by computing confidence intervals around the observed mean on each scale for the students in each condition. Estimates of the Chanute and ATC population standard deviations were used in computing the various confidence intervals. If the total sample mean for the Chanute trainees (n=2484) or for all ATC trainees (n=12666) fell outside a particular confidence interval, it was taken as evidence that the sample differed significantly from the respective population on the scale in question. Since the estimates of the population standard deviations are not reported, we are unable to check the calculation of the various confidence intervals. However, the procedure seems to be a reasonable approach to the analysis of these data.

It might be wished that the authors had taken greater care in summarizing the results in terms of completeness and accuracy, but they have reported the data in sufficient detail (see Appendixes F and G) that interested readers can search for other relationships.

Discussion. No further comment is needed.

Instructor Attitudes

Method. The description of the instructor attitude scale is adequate as background for presenting the results.

It would have been helpful to have given a fuller description of the sample of instructors since it is apparent that they differed with respect to the duration of their experience with the PLATO-based training system.

Results. It is commendable that reliability estimates were computed for those scales where it was possible to do so. Unfortunately, however, there are some difficulties with the statistical techniques used on these data. For example, the current description of Table 28 appears to be somewhat misleading, as it describes "t-tests for the attitudinal data analyzed as repeated measures with correlated observations." This would seem to imply that a series of correlated t-tests had been computed on the scaled responses for the two administrations of the survey. However, the analyses actually reported in Table 28 were independent groups t-tests. Since there is an overlap of 10 instructors who were surveyed in both administrations, it is likely that the assumption of independence is violated in these data. Hence, the validity of the probability statements in Table 28 is questionable. A more defensible procedure for assessing attitudinal changes would be to concentrate on the responses of those instructors who had been surveyed twice. A multivariate analogue of the correlated t-test could then be done on the two sets of scale scores.

Responses to the items underlying the scale labeled "PLATO affect" (i.e., items 23 to 34 in Appendix H) were examined more closely in supplementary analyses. While a more complete description of the "+" and "-" categories in the Chi square analysis would be helpful, the Chi square results confirm the earlier t-test results regarding the "PLATO affect" scale. Figure 9 gives a graphic portrayal of the fact that attitudes became more negative at the time of the second administration whereas they previously had been generally positive.

Discussion. The authors' interpretation of the declining attitudes observed in the survey responses seems plausible; a decline in perceived role importance could result in less favorable attitudes toward CBE. The authors' suggestions regarding increased instructor involvement appear to be well founded and should be investigated empirically in future CBE applications.

Some additional comments seem in order regarding the interpretation of these results. First of all, the timing of the questionnaire administration should be noted. The initial administration came in February 1975 after only a few weeks of operational use of the PLATO system in the revised common course segment, and the second came in July of that year. Although it occurred several months into the operational trials, the second administration must still be considered to have been quite early in the life span of the Phase II operation. Many instructional and coding problems remained in the lessons (most of which had not yet reached Chanute's validation criterion) and the group-pacing of the shred areas had only recently been completed. In short, there were still a number of "bugs" in the newly-revised courses which may have negatively influenced the instructors' attitudes toward PLATO in the time frame of the second survey.

Another item suggesting that the decline in instructor attitudes may have been due to temporary factors is that more recent interviews with instructors (Klecka, 1977c) revealed a generally positive attitude toward PLATO. It is not known how many of the individuals interviewed by Klecka had been part of the instructor force at the time of the AFHRL survey. It is possible that substantial "turnover" had taken place so that some newer instructors learned a "PLATO role" without having first become accustomed to a more traditional role. Without any previous role pattern or

expectations, new instructors may adapt more easily than did the original staff. Perhaps, however, the most direct way of testing the hypothesis that the attitude decline observed in the AFHRL survey of July 1975 was due to temporary factors would be to administer that survey a third time (i.e., to the current group of instructors).

Impact on Training Activities

Procedure. It is highly commendable that observational data were collected and reported by the service test evaluation team, but some aspects of the method of gathering these data are not clear from the report's description. In particular, it can not be determined from the report whether the observation categories were used in making the observations or whether they were arrived at after the data had been collected. Although a highly structured observation instrument would have been impractical, it would be reassuring to know that the observers had at least been instructed to attend to some general categories of behavior and that there had been some ground rules for the classification and reporting of observations to minimize observer bias.

Results and Discussion

Conduct of training. The description of the adjustments to the standard operating procedures (made necessary by Chanute's CBE implementation) is enlightening. The informal "sign-up sheet" scheduling system seemed to work fairly well; however, it is not known whether it would continue to be a smooth and convenient way to allocate terminal time under conditions of greater demand for this resource. A more sophisticated scheme may be necessary in a full-scale operational environment.

The report indicates that the Chanute site occasionally suffered from shortages of computer memory space (known as extended core storage or ECS). It should be noted that such problems occurred only when ECS usage at Chanute exceeded the allocation guaranteed to them. The two general ways that this problem can be solved are (a) making more ECS available for each user (by adding expensive hardware to the system's mainframe or by restricting the number of users on the system), and (b) reducing the amount of ECS required by each user. The AFHRL report implies that if PLATO were an Air Force resource, memory problems would be eliminated. In order for this to be a solution, restrictions on the number of users on an Air Force PLATO system could allow each user to occupy more memory--probably with increased costs per user. The second approach to the problem would require the average Chanute lesson to be reduced to one-half or one-third of its current size. The latter solution would consume slightly more computer disk storage (a relatively inexpensive resource) but would require a major modification effort to partition existing lessons into a greater number of smaller modules. Future ECS problems could be avoided by careful planning early in the course of a project. The most viable approach would be to keep the ECS requirements of discrete lesson segments under 2000 words.

Student interaction. The description of student interaction in the traditional and CBE classrooms is useful. It affords a much fuller picture of the transactions in the training environment than could be had through test scores and attitude responses alone.

The classroom interaction rate data for the vehicle training lecture sessions is especially informative. Based on data supplied by the AFHRL report, the following comparison can be made between the number of questions answered by

students in a PLATO class and in a lecture class. According to this section, 11 students answered 77 questions in four hours, i.e., less than two questions per student per hour. By summing the information in Tables 17 and 31, one can calculate that PLATO students answered 155 questions (even more when reviewing is counted) in an average of 369 minutes, or more than 25 questions per student per hour.

We take issue with some of the comments made by the report authors in comparing CBE and conventional instruction. For example, their criticism that in comparison to instruction by lecture, CBE lessons are less easily adapted to the needs of students may be true, but the arguments by which they draw this conclusion are not valid. "Adaptability" as used in Chapter V seems to mean the ability to reshape the delivery of material to a class. This is rarely attempted in CBE because of the availability of "individualization", meaning adaptation for each student rather than for each class. "Adaptability" also implies the ability to halt normal training when a class-wide misunderstanding is noted and to then re-teach any necessary concepts. Because the lecture format is not standardized, this adaptability fulfills a very great need--it compensates for omissions or inadequate explanations by some instructors. With well-tested standardized media presentations, however, this "total adaptability" becomes unimportant. Furthermore, Chanute CBE lessons were not, in our opinion, designed for either adaptability or individualization, so that the AFHRL report comments may be appropriate if applied to Chanute CBE lessons, but not necessarily to CBE in general.

Because both the PLATO system and the now-freed-from-lecture instructors can gather data about student questions as an aid for revision, we do not agree that, "[a]ttempting to keep a record of questions . . . would be a difficult

if not impossible, task for a single instructor. Revisions based on just this sort of data can give CBE lessons a huge advantage over other media. Furthermore, the capability of the PLATO system to collect, store, and organize data for formative evaluation or individualized training is certainly greater than that of the typical classroom lecturer. Nevertheless, the instructor who monitors a CBE classroom is in a position to observe a number of problem areas in the CBE lessons and, if he has the inclination to do so, can supplement and clarify the student interaction data collected by the system itself. Perhaps the Chanute instructors could be given some additional training in techniques for gathering formative evaluation data; the recently-added "TERM-comments" feature, for example, could be used quite effectively by instructors who have observed areas of needed improvement in the CBE lessons.

Instructional content. The observation that students in this population were less interested in theory or abstract principles of engine operation than they were in laboratory tasks confirms the result noted earlier from their responses on the long-form attitude survey. We would also underscore the observation that the ability to repeat in a tireless, standardized way drills and exercises which a human instructor would disdain and execute poorly is one of the most valuable assets of CBE.

Instructional styles. The comments in this section with regard to the differing teaching styles of instructors and the adjustment that students had to make as a result are quite interesting. It would seem that this phenomonon occurs in other educational settings as well, but it may be more acute in military training environments where instructor changes occur frequently. That a similar adjustment was required in going from one CBE lesson to another was also an

interesting observation. In this case, however, it implies a lack of product uniformity standards during lesson development. Had such standards been employed, the lessons would have been more similar in format and would have required fewer adjustments on the part of the students.

We would also note that the comments in this section concerning the active exploration of the characteristics of PLATO instruction stand out in strong contrast to the soporific reactions of students to lecture presentations. Even the effort of the students to "beat the system" may be viewed as positive when compared to the lack of interest exhibited in the lecture classroom.

Discussion. The authors conclude in this section that "control of the instructional material must be handled very carefully." It cannot be assumed, they say, that all students will be motivated to do their best work. That is, given some control over lesson sequencing, there will always be a few students who seek to "beat the system". Furthermore, student performance has not been shown to be universally better when lesson sequencing has been put under the control of the student rather than the computer. However, Seidell (1975) has shown that high-performing students can benefit from a degree of student control over sequencing. Learner control may be most effective, therefore, when individualized according to performance record. For a review of research on the issue of learner control in CBE, see the article by Steinberg (in press).

Conclusion. We have previously noted our reservations regarding some of the authors' observations, but we concur with their conclusions that (a) PLATO did not have a major adverse impact that precluded its potential effective use in technical training, and (b) refinements in implementation procedures could reduce the negative impact of those problems

that were noted. We believe that many of these refinements could be made quite easily.

Impact on Existing Air Force Regulations and Guidance

Since we are not part of the Air Force training environment, most of the remarks of this section are beyond our sphere of direct experience. As close observers of the entire service test at Chanute, however, we do agree with the statement that the use of the PLATO system as an instructional resource did not necessitate great changes in Air Force regulations, manuals, and procedures. However, our view of the service test leads us to underline the caveat that future Air Force PLATO efforts should be conducted in the environment of systematic, in-depth instructional system development.

New Training Capabilities

It is true, as the authors indicate, that the main goal of Phase II was to get operational training underway as rapidly as possible. This orientation limited the use of PLATO to presenting low-level instruction in automotive fundamentals using instructional strategies similar to those used in conventional programmed texts. There was little opportunity, in Phase II, to attempt applications which would utilize the unique capabilities of the CBE medium.

We agree that the two areas discussed here as potential cost-effective applications of the PLATO system (i.e., diagnosis/troubleshooting and performance testing) are prime candidates for achieving cost-effectiveness while substantially improving the quality of training. We also agree with the tentativeness with which these recommendations are put forward. The successful development of any CBE courseware depends upon a great many factors. Only by assessing the

instructional materials to be produced, the environment in which they are to be used, the capabilities and experience of the instructional developers, and the management of the production effort can one begin to predict the chances for success. With the right combination of these factors, however, the hoped-for advantages of these CBE applications could probably be realized.

Overall Summary and Conclusions

In this section the authors summarized the important results of this extensive chapter on instructional impact. The major findings can be summarized as follows:

1. The impact of PLATO on student attitudes was generally positive.

2. Instructors reported positive attitudes toward PLATO initially, but a second survey showed a decline in attitude. Based on more recent attitude data (Klecka, 1977c) showing a generally favorable attitude toward PLATO, we offered the hypothesis that the negative attitudes found in the second AFHRL survey were due to temporary factors.

3. PLATO had no significantly adverse impact on conduct of training which would preclude its potentially cost-effective use. Furthermore, refinements in implementation could alleviate much of the negative impact that was observed.

4. Existing ATC regulations provide adequately for the utilization of CBE in operational training; no major changes in these documents are needed to incorporate CBE.

5. Suggestions for additional PLATO applications which would utilize the unique capabilities of CBE were made.

We concur in the conclusion that "the overall impact of PLATO has been more positive than negative. There is no reason to believe that PLATO cannot prove to be an acceptable and useful training medium."

VI. INSTRUCTIONAL MATERIALS DEVELOPMENT

This is a well-written chapter providing a wealth of detail about the process and products of the lesson development efforts. Although headings are sometimes a bit misleading, the content is addressed in a logical and orderly fashion.

Method

No comment is needed.

Results and Discussion

Process description. It is indeed accurate to say that Phase II contrasted favorably to Phase I in terms of the rapid production of effective lesson materials. It should be pointed out that both the methods used and the management staff changed substantially between phases. The contribution of each to the enhanced efficiency is large, but the relative importance of the components is, unfortunately, unknown. The model which did emerge during Phase II was a reasonable fit to the constraints of the technical training environment. Future applications of CBE in a similar setting would do well to take it as a starting point and evolve further refinements.

The nature of technical training. It is certainly true that, as this section states, the characteristics of the courseware development effort in Phase II were defined by the nature of Air Force Technical training. In contrast to higher education, where there is considerable emphasis on development of the higher levels of cognitive processing and learning as an end in itself (i.e. "education"), the Air Force technical trainee is taught only what he needs to know for apprentice-level entry into a career field. It is

assumed that further advancements will require further preparation in the form of Career Development Courses or On-the-Job Training.

In the technical training environment, over-training is costly and is to be avoided just as is under-training. This philosophical orientation toward training (known as the "lean approach") is realistic and effective, but it narrows the range of CBE capabilities which can be exploited. Whereas in higher education settings the simulation and modeling capabilities of CBE are usually considered to be quite attractive (because they can be used in developing higher-level cognitive skills), these features were not seen to be so important in the apprentice-level training provided in the Special Purpose Vehicle Courses. Hence, such sophisticated applications as diagnosis/troubleshooting and performance testing (discussed in Chapter V) were not attempted.

CAI Lesson Development

The model. We agree that the procedural model described in this section is a generalized composite of the process actually used. Although individual deviations from it were common, the description provided by the authors conveys the general approach that was followed. The reader should note that the report authors abstracted this description from a series of interviews with service test personnel. No formal delineation of procedures had been made by the ISD staff.

Central to the model is the concept of a team approach. In contrast to the pattern followed during Phase I in which each individual author was given sole responsibility for all phases of lesson development, two lesson production teams were established in Phase II. Each team included

two to three of the original authors, but some of the development tasks were shared by individuals who had more specialized duties. That is, an instructional programmer, a computer programmer (i.e., a "coder"), and a subject matter expert supplemented the authors' efforts. The authors had had previous experience with CBE by virtue of their Phase I work, but the other team members (including the instructional programmers) had only had experience with conventional programmed instruction and stand-up instruction--they had not previously developed lessons for a CBE system.

As stated in the AFHRL report, the procedural model is a description of the processes followed in step 4 (i.e., "Plan, Develop, and Validate Instruction") of the overall model for instructional systems development (Figure 11). The first three steps of the overall process had already been completed by the ISD team prior to the start of Phase II activities.

The nine steps in the lesson development process are an adequate portrayal of the procedures actually followed. General descriptors of the steps are:

1. Lesson selection,
2. Research,
3. Lesson planning,
4. Off-line lesson preparation,
5. On-line coding,
6. Pre-tryout review,
7. Student tryout,
8. Validation,
9. Finalization.

A more complete description might have indicated the nature and extent of individual deviations from this model. We also would point out that in the lesson planning stage (step 3) the only optional media used at Chanute were

rear-projected microfiche images. Touch panels and random-access audio devices were not used in any way during Phase II, to our knowledge. Francis (1976a, p. 66) provides a survey of the use of peripheral equipment at ARPA/PLATO project sites.

It is not apparent from the discussion of the model that step 8 was separated from step 7 by a period of up to six months, but the authors do make this point later in the chapter. For more information about lesson development procedures in Phase II, the reader is referred to the entire first chapter of a report by Klecka (1977b).

Assessment of the model. This section gives a further elaboration of Chanute's courseware development model and assesses its strengths and weaknesses. While a more complete analysis would be useful for the sake of future development efforts, the information provided does give a general overview and is consistent with space constraints.

Many of the problems noted relate to the implementation of the model at Chanute and are not disadvantages inherent to the model itself. The problems with communication, for example, developed because of the sudden manner with which the Phase II effort was initiated. The PLATO authors were put under the direction of the ISD team at a time when the ISD group had already completed most of the initial planning for the course revisions. The PLATO authors had not participated in this planning and the ISD group had had little previous experience with CBE (some of the ISD personnel had attended a portion of the TUTOR language workshop at CERL two years previously, but had never done any direct CBE lesson development). Many basic issues in philosophy and orientation had to be settled before the effort could get underway, and the process was complicated by the pressure of a tight production schedule. These problems in communication would

not have been so imposing if all groups had had adequate training and if all initial planning could have been done jointly.

Because the PLATO authors were the only team members who had had previous experience in CBE, they retained a central role in the Phase II effort. Their role was not drastically different under Phase II than it had been under Phase I. They still had primary responsibility for most aspects of lesson development, but relied on the instructional programmers and subject matter experts as resource persons and for quality control. In future applications, where more care can be taken in training and in assignment of roles, a more efficient team organization should be possible.

The development of the student router, test administration routines, and other course management software followed a different model as indicated in the report. For a detailed description of the uses of the PLATO system as a management tool at Chanute, see the second chapter of Klecka (1977b).

Appendix I

Because of the importance of Appendix I to the understanding of the conditions and procedures in the Chanute PLATO project, this critique devotes a section to comments about it. The appendix consists of several parts, the most important of which are the scenario and the sample lesson.

Scenario. The appended scenario is a livelier and more picturesque view of the lesson development steps described in Chapter VI. As such, it is a very valuable addition. Since any scenario can consider only a limited number of situations if it is to be of reasonable length, there is the possibility that the reader will gain an incomplete perspective of the project. To avoid that potential

problem, we have included below several additional considerations that should broaden the reader's view.

Some authors suffered more from morale problems than did "Mr. Arthur". Authors, frustrated by the constraints and demands of their environment (e.g., terminal shortages, uncertain project goals, lack of administrative support) formed constantly shifting alliances with and against each other, the ISD group, the evaluation staff, and the traditional course personnel.

Because of the author attrition noted, quite a number of lessons were written by one author and, after running a few students, revised by another. This may explain some of the inconsistencies within lessons noted previously and in the following section.

Sample lesson. We would encourage all readers to read through carefully these sample frames from a representative lesson. They exemplify the comments made in this chapter in very concrete terms. From our perspective, the lesson selected is typical of those produced during Phase II.

Strengths and weaknesses are found, not only between lessons, but also within them. In many cases the quality of one aspect of a lesson varies widely from frame to frame within that lesson. For example, in the clutch lesson described, the graphics are very well done, but are not always available when most needed. Frame 39 gives a long "knee-bone-is-connected-to-the-leg-bone" description that desperately needs graphic support (preferably with animation). For a second example, the multiple choice questions within the body of the lesson are reasonable and integrate well with the presentation, but the choice of matching items in the MVE includes both tangibles (copper wires) and intangibles (solid friction) as well as singular and plural forms. Both examples demonstrate the variation in lesson quality

we have observed in the Chanute materials and seem to indicate that the potential for higher quality lessons lay almost within the project's grasp.

Courseware Development Issues and Constraints

Prior lesson development efforts. In this section the authors give a general description of the activities, decisions and outcomes of the first two years of the project, i.e., Phase I. During this period the project's goals were either undefined or were changing rapidly--it wasn't until the beginning of Phase II that a cohesive curriculum development effort was begun. The lessons that were produced in Phase I were developed under the "Autonomous Author" approach. Since this basic model had been used successfully at the University of Illinois, CERL had advocated initially that individuals be given full responsibility for developing lessons, i.e., to act as independent authors. Unfortunately, this approach was not well-suited to the Chanute situation because several key prerequisites for its success (i.e., self-selection of authors, thorough subject matter knowledge, relevant instructional design experience) were absent. Later efforts by CERL to foster a team approach were unsuccessful because of the fluctuation of project goals.

Although, as noted, self-training in programming techniques occupied a great deal of time during Phase I, we see this less as an actual need and more as the authors' attempts to "do something useful" during a period when other goals were rapidly changing.

The diagnosis that higher management had little interest and provided little support to the PLATO project because of its research orientation is consistent with our observations and it seems to be an important problem for future sites as well. The use of a novel medium such as PLATO suggests the

need for a research orientation to examine the potential of the medium, but a research orientation may seriously jeopardize the acceptance of the new medium and limit the commitment toward it on the part of higher-level administrators.

The conclusion that Phase I resulted in a fragmented non-curriculum not conforming to civilian or military standards for training is congruent with the findings of the May, 1974, review committee.

Project management. This section includes an excellent description of the differing expectations of the ISD team and the author group. During the transition to Phase II, the authors felt they were being told to sacrifice quality for high production; the ISD staff felt the authors were unmotivated. On many issues, the two groups' views were vastly different. Initially the ISD staff hoped to produce PLATO lessons as quickly as programmed texts (50hr/hr). The authors were used to working at a rate about an order of magnitude slower than that (400hr/hr). Both estimates (obtained through CERL interviews) were unrealistic and conflict on this point was inevitable. It is significant that problems such as this were solved or circumvented quickly so that courseware production could proceed.

Other management problems arose because the use of CBE was seen by course personnel as being a temporary experimental project having little place in operational training. Future applications should seek to utilize CBE as an important resource rather than treat it as an artificial and short-lived experiment. If this can be done, it should be possible to circumvent many management and implementation problems.

At the end of this generally excellent section, the AFHRL report indicates that "[b]eing linear and lean, the lessons did not tax the capabilities of the PLATO system."

The distinction between "taxing" and "exploiting" the various powerful features of the PLATO CBE system was confused frequently during Chanute's history. Members of CERL's MTC staff and some members of the Chanute author staff regularly advocated the exploitation of system features for sorting student response data, providing feedback for specific wrong answers, and for judging the adequacy of a wider variety of student responses. This advocacy was often understood to mean "the PLATO system has clever and unique features which ought to be used because they are so unusual, because they 'give the system a workout' (as if the system somehow grew sluggish if not regularly exercised), or because the use of these features justified and acclaimed the PLATO system." In fact, those encouraging the use of these features saw instructional or administrative problems which had potential solutions available within the system itself. We make this comment to illustrate the nature and extent of the problems caused through differing concepts of the role and capabilities of the computer. Hopefully, these conflicts can be circumvented in future development efforts through adequate training.

Hardware and software related constraints. We would agree with the assessment that the site was not restricted by the features and ease-of-use of the TUTOR language. While it is true that some of the authoring staff had limited programming ability, others were quite capable and most programming needs could be handled without outside assistance. The presence of "coders" (i.e., persons whose primary role was programming the computer rather than the development of teaching sequences) on the staff greatly enhanced the effectiveness of the site.

For a variety of reasons, including the fact that it was one of the first remote PLATO IV sites, Chanute did suffer from hardware problems to a greater extent than any other

ARPA site. The shortages and delays associated with terminal and microwave installation were especially detrimental to Chanute. Other resource shortages (i.e., in ECS, disk file space, and computing power) were experienced by all users and hindered the lesson development process at Chanute as well. Fortunately, most of these problems have been alleviated through various hardware enhancements to the central processing system.

Courseware development. Chanute was one of the earliest users of microfiche. As such, they spent a great deal of time during Phase I exploring and defining the limits of the microfiche system. Nevertheless, it seems an exaggeration to state that several man-months were spent during Phase II in refining this process. In any case, the story of Chanute's use of microfiche is so extraordinary and enlightening that Francis (1976a) devoted a sub-chapter to describing it.

Other problems described in this section relate to the fact that the authors were not true subject matter experts (so that they had to spend time in researching the content to be taught) and the ISD policy of limiting the amount of student testing a lesson was to have prior to its operational use. These problems should be addressed in planning for future CBE development efforts.

We agree heartily that there was a problem in determining the proper depth of training for an apprentice mechanic; this resulted in some apparent inconsistencies in the Chanute lesson materials. For example, the basic electricity lesson delves fairly deeply into theory, teaching mechanics trainees about atoms and electrons, but less than an hour is spent in the only lesson describing the complexities of emission control systems, PCV valves, and diverter valves.

Part of the confusion may lie in the fact that the Specialty Training Standard (STS) for most knowledge items

(the material taught by CBE) indicates that students should be taught to the "B" level. The "B" level is defined as: "Can explain relationship of basic facts and state general principles about the subject. (PRINCIPLES)" Although the course documents specify the depth of training to be at the "B" level, the lessons which were produced seem to us to be aimed at the "A" level. The "A" level indicates a more superficial level of training and is defined by: "Can identify basic facts and terms about the subject. (FACTS)"

Since field results (reported in Chapter III) indicate acceptable student performance, yet the teaching and testing are not at the "principle" level as defined (see Appendix I of this report or Klecka, 1977a), it may be that training at the "A" level is sufficient. This discrepancy between training levels, plus the problems noted in the AFHRL report, gave rise to the "frequently expressed concern about insufficient depth of training" voiced by the authors.

Authoring. The discussion in this section further illuminates some of the problems felt by authors under the conditions of the service test. Attention to ways of circumventing these problems should be given in future efforts.

Since the contents of the Lesson Characteristics, Instructional Strategies, and Interaction sections are so directly related to the CERL publication by Klecka (1977a), and because the elaborations and added emphases of Chapter VI are consistent with our observations, it is not necessary for us to comment further.

Instructional programming features. Although many Chanute lessons used microfiche, it is remarkable that few, if any, ever used a microfiche as part of an end-of-lesson or block test. Similarly, although students were shown many microfiche, rarely were they asked any questions about them during the lesson. The effect of this unusual use of

microfiche is that the information presented via microfiche seems related, but less important, than information presented in other ways. It is stated elsewhere in the AFHRL report that students found the use of microfiche images very motivating; it may be that motivation was the primary objective and was achieved.

Graphics, typically, were more completely integrated into the lesson. As this section of Chapter VI observed, slow-plotting graphics are disliked by students. In some cases overly-complex screen graphics were used when microfiche might have been employed more inexpensively. In one documented case (Francis, 1977a), one of the best and most hard-working programmers at Chanute spent two weeks copying a single (slow-plotting) display of an electrical schematic.

The last point we would like to make about this section is to re-emphasize an AFHRL observation which we feel summarizes our main criticism of the lessons. Students reportedly complained that test questions did not say things in the same way as the text in the body of the lesson. We agree that there is evidence to suggest that the students were merely associating words, not learning concepts.

Student evaluation. No comment is needed.

Lesson validation. No comment is needed.

Validation techniques. This section also closely follows Klecka (1977a) and requires only one further comment. Among the "technical errors" mentioned at the end of this section were a sizeable number of lesson execution errors. Although these errors are carefully documented by the computer, several lessons which had passed the validation criteria continued to cause this major kind of error as long as nine months after validation. This suggests a very narrow view of "validation".

Conclusions

We concur with the conclusions that:

1. Phase II lesson development procedures were more effective and efficient than those used in Phase I.

2. The Phase II lessons did not exploit many CBE capabilities because of inadequate resources and a lack of relevant training.

3. Role specialization contributed to increased efficiency of lesson production (i.e., we, too, expect a team specialist approach to emerge as most appropriate for technical training applications).

4. The PLATO system provided ample flexibility in design strategies and data collection.

5. Sophisticated CBE capabilities may not be necessary for lessons having limited (i.e., low-order) objectives.

Chapter VII. MANAGEMENT OF THE PLATO BASED COURSE

We find this whole chapter rather complete and perceptive. We expect that future development efforts can profit greatly from the discussion it provides. Due to space considerations, our comments are directed only at the latter sections of the chapter.

Management of instructional material. Two items related by Chapter VII deserve additional emphasis. We agree with the suggestion that it is not wise to automate a function merely because it can be done or because it might save a small bit of time. It indeed seems likely that student and instructor motivation and morale might slip if certain scheduling, monitoring, and controlling functions were left entirely to the computer. The next section of the critique discusses some problems that were pointed out to us concerning the new role of the instructor.

The AFHRL report makes a comment that should be reflected back to the operational problems noted and to the results of the cost-effectiveness evaluation when it observes, "[t]he course was operated under the assumption that PLATO would not reduce instructor requirements and therefore the system should be utilized only in ways that fit into traditional modes of instruction." Although such constraints are sometimes necessary, they force assumptions and allow interactions which drastically change the environment of implementation. In our view, the predominant attitude at Chanute was, "We will permit the use of PLATO in those places where we can force it into traditional roles," rather than, "We will adapt our methods and procedures so as to take maximum advantage of the potential of PLATO."

Instructor role in PLATO-based training. The AFHRL report draws a somewhat unpleasant portrait of the role of

the instructor teaching a block of the automotive course after it had been modified for PLATO by ISD. This picture is, unfortunately, supported by the attitude data from Chapter V. Two bases for discontent emerge from the discussions in this chapter.

First, the lessons themselves were a problem. By most measurements, these lessons were not "polished", i.e., they required the constant presence of a knowledgeable proctor to assist students having difficulties. Nagging problems kept cropping up for the instructor. And, as described in this chapter, efforts to correct those problems were thwarted by an unfortunately complex set of procedures. (Recent additions to the PLATO system have provided a convenient way for lesson problems to be reported to the author staff without entailing the "red tape" noted in the AFHRL report and without causing major interruptions to the work of the PLATO staff. Chanute personnel have implemented this system and instructors are using it.)

A second problem was described by the head of the ISD group (personal communication) as the reason why group-pacing is worse for instructors than either self-pacing or lock-step. He explained that because the slowest student sets the rate, the instructor cannot sit down to review and carefully teach the slower students--that would generally mean the group would move at a still-slower rate. Instead he can only prod the student, or sit with the slow student and give him the answers so the group can proceed. With self-pacing, the instructor can help the student by individually tutoring him, by providing additional materials to fill missing prerequisites, or by restarting the student at the point at which he found difficulties. Lock-step pacing usually means stand-up classroom instruction with the instructor as the center of attention and clearly in command. With group-pacing, the

slowest student provides the basis for proceeding to the next topic; in many ways the instructor is peripheral or superfluous to the activity taking place.

The last part of this section points up a typical problem of implementations: the conditions under which the materials were validated are not the conditions present when the materials are used for operational training. There is a significant threat to the integrity of the validation because students are now allowed or encouraged to take notes for use on the end-of-lesson tests which were used as the validation criterion. While it may be that note-taking is an important learning strategy, the effect of using notes during the test is likely to be significant. Furthermore, CERL staff observing in the Chanute PLATO classroom after the lessons had been validated saw students "getting answers" by questioning other students or glancing over at a neighboring terminal. Test performance under these circumstances may differ from that under the conditions originally planned for the lessons (i.e., no notes and each student doing his own work).

In general, the report authors have provided valuable insight and have made excellent recommendations regarding actions to be taken by those in charge of maintenance and operation of the special purpose vehicle course. The Chanute staff would do well to heed these recommendations.

Management of student testing. This section accurately depicts the various capabilities of the PLATO system and its utilization by the Chanute author and instructor staff. For greater detail about instructor comment storage and retrieval, consult the chapter by Klecka (1977b) dealing with management applications at Chanute.

General Conclusions Concerning Management

The conclusions presented are an appropriate summary

for this chapter. One sentence is especially interesting: the report says "[w]hile different techniques were necessary to allow for PLATO's idiosyncracies, these techniques served to facilitate efficient training rather than impede it." This is a familiar finding for many management tasks undergoing computerization. An explicit list of examples of such techniques would have been especially valuable.

Chapter VIII. HUMAN FACTORS ANALYSIS

From the view of the specialist in Human Factors, this chapter is somewhat disappointing in its lack of quantitative data. For example, it would be interesting to have specific data for the experience at the Chanute site on terminal reliability in addition to the CERL-provided data on system reliability. The reliability information provided by CERL includes terminal reliability data averaged over the entire system. Being located only about 15 miles from the CERL hardware maintenance facility, the Chanute site's experience may actually be better than the system-wide average reported by the authors.

From a practical standpoint, however, it seems clear that all major considerations of systems design have been evaluated for potentially fatal limitations and that no such limitations have been found. Given the limitations of resources under which the evaluation was performed, the coverage on this point seems entirely appropriate to the needs of the Services.

One point that may need clarification is the recommendation for indirect lighting to prevent glare from the face of terminals. Many people include diffused light as a form of indirect lighting. Strictly speaking, they are correct since the source of light itself is not visible. However, glare from translucent diffusers can be just as troublesome as glare from exposed bulbs or tubes. The only sure cure for the problem of glare from display screens is to insure that a dark ceiling is the only thing visible by reflected vision to one seated at a terminal. This may be achieved by sharply directional lighting deeply recessed in the ceiling, reverse-angled or vertical screens, or a combination of these approaches.

Chapter IX. EXPERIMENTAL STUDIES

The experimental study reported in Chapter IX is the only one of seven studies planned for Phase III that was completed. The "Historical Perspective" section of Chapter II indicates that it was originally planned to refine each of these seven studies through three separate iterations. The material reported in Chapter IX represents the one and only iteration of the Technical Order (TO) study that was completed.

Lesson Sequence and Development Time

The description given of the games used in the TO instructional sequence is accurate. It is important to note that the strategies used in these games are sufficiently general as to allow them to be used to teach some other subject matter. That is, there is nothing inherent in the strategies which restricts their use to the TO material.

It is difficult to say how an automotive repairman trainee might perceive these games. To CERL evaluators, however, they appeared to be either so complex that learning the rules and mastering the game was more difficult than mastering the material being taught or that they were lacking in motivational power. Readers should note the complexity of the "Wizzard Game" described and illustrated in this section of the report. Not only is the game complex but the rules lack any obvious relationship to tasks involved in finding and using TOs.

CERL personnel have verified that the potential for the use of gaming strategies is high for TO instruction. An easily learned game requiring the participant to classify TOs in correct order was written by CERL personnel. This game was interesting and challenging even to those who had no

interest in TOs. Several PLATO authors played this game simply for its recreational value and became facile in ordering lists of TOs in the process. This game was not used in the TO sequence because it was decided by those directing the study that it did not meet the design criteria that had been specified.

The evaluators in charge of the study are to be commended for attempting to measure the development time expended for each of the game lessons and the mainline instructional lessons in the TO sequence. Data of this sort are scarce but are of obvious importance in answering questions of cost and efficiency of production methods. Future development efforts should attend to the problem of collecting these types of data.

Method

Evaluation design. The use of three conditions--conventional non-PLATO instruction (NP), PLATO-based version (PV), PLATO with adjunct gaming (AG)--was twofold. One purpose as reported, was to test the efficacy of gaming strategies for improving student performance and attitudes. The other was to see if PLATO-based instruction by itself could accomplish this result. Conventional instruction in the use of TOs had long been recognized at Chanute as being ineffective. Thus, a complete set of PLATO lessons was developed to teach the objectives of the conventional TO sequence. The games for the adjunct gaming condition were then appended onto this set of lessons by interspersing them among the instructional modules as shown in Figure 12.

The fact that the games were added onto a sequence of simple tutorial PLATO lessons, which were essentially complete in themselves, was not the most favorable environment in which to determine the value of gaming strategies. In

this context, they are simply an appendage which would certainly lengthen the time needed to complete the sequence. Moreover, in the event that student performance was already high with the unadorned PLATO TO sequence, any improvement coming as a result of the games would be difficult to detect.

Measures. The reporting of the actual attitude questionnaire would have been useful for those who might wish to use it or make independent judgments regarding its validity. Additional information concerning the reliability of test scores and attitude scales is presented in a later report section.

Procedures. The discussion of procedures suffers somewhat from lack of clarity. This, no doubt, is largely due to the complexities caused by the differing schedules for the general purpose and special purpose courses. Such complexities are to be expected when research must be conducted in an operational environment.

Results

Lesson performance findings. There are two main difficulties with the analysis of procedures used for the lesson completion time and lesson score data. First, it is probably inappropriate to have conducted univariate tests on each of the seven modules for reasons stated earlier in this critique. Second, a more sensitive measure probably could have been had by combining lesson time data and the lesson score data across the seven modules. Given the distribution of mean times and scores shown in Table 34, however, it is not clear that even the overall time and lesson score measures would have detected a difference between the PV and AG conditions.

Attitudinal findings. The PV condition students had significantly higher attitudes toward TOs than did the NP and AG students.

Discussion

The games introduced into the TO instructional sequence were simply appended to the established lesson sequence. One would expect, therefore, that these games would lengthen the completion times of these lessons. That such a result was found comes as no surprise. The fact that the attitude towards the subject matter was poorer for the students in both the AG and the NP conditions than for the PV condition is interesting. It would seem that attitudes were improved by the simple use of PLATO but that this advantage was negated by introducing games into the sequence. This seems to verify our opinion that the games were amotivational and dull. Without being able to view the questionnaire and because of the acknowledged problems with the internal and external validity of the study, such conclusions can only be put forth tentatively.

The AFHRL evaluation report wisely refrains from generalizing from the study's findings on gaming. Had the study been able to proceed, it would have gone through two more iterations during which the games, lessons, and data collection procedures would have been refined. Such refinement might have included integrating the games into an instructional sequence instead of just appending them to a sequence of PLATO lessons. In this way a more valid test of the efficacy of gaming strategies could have been obtained.

Finally, it is important to note that the PLATO version of the TO lessons accomplished much of what it was hoped the adjunct games would. These lessons, without the games, saved student time and produced more favorable student attitudes toward the subject matter. In fact, we feel that the conclusions of this chapter overlook (or at least underemphasize) one of the most important findings of this study. Chanute had a long-standing problem (i.e., the effective teaching of

Technical Orders) which had resisted several previous attempted solutions. The results of using PLATO strategies without the games (higher learning efficiency with better attitudes) suggest that PLATO may be the long-sought-after solution for this problem. The overall conclusions of Chapter IX have a tone of failure, although from the view of a student, instructor, or course administrator, the results are positive.

Chapter X. OVERALL CONCLUSIONS & RECOMMENDATIONS

Overall Conclusions

The overall conclusions adequately summarize the findings of the previous chapters and contain no surprises. In their brevity, they overlook a few problems (such as declining instructor attitudes) and a few opportunities (such as the potential for computer-aided test delivery), but concisely remind the reader of the salient outcomes. They are restated here (in abbreviated form) for the convenience of readers who do not have access to the AFHRL report.

1. The PLATO system was an effective medium for presenting task-related cognitive materials.

2. The Chanute PLATO application was not cost-effective when compared to courses employing less sophisticated individualized media to perform similar functions in this application. However, as shown by our comments on Chapter IV, the Chanute application may have approached cost-effectiveness in spite of the fact that it may not have required the full capabilities of CBE.

3. PLATO did not have a large impact on the main features of the training environment; it was acceptable to students and instructors and it was compatible with existing organizational structures and controls. However, little in the way of new training capabilities was demonstrated.

4. Due to the complexity of the courseware preparation process, greater efficiency resulted from a team approach employing role specialties than from the single instructor/author approach.

5. The Chanute effort was limited in attempting additional applications by constraints in management, resource acquisition, personnel training and experience.

6. Some management difficulties were experienced because the PLATO system was not an Air Force resource. Adjustments were necessary in the areas of training activity scheduling and course instructional design selection.

7. Few usage problems were present in terms of student interaction or courseware authoring. PLATO was found to be a reliable tool once system expansion and experimentation was moderated.

Conclusion #6 requires a comment. It implies that certain management difficulties caused by resource constraints could be eliminated by Air Force/military control of a PLATO system. Although maintenance time, for example, could be shifted to accommodate Chanute's needs, adverse effects might occur for other users (military and civilian) in other time zones. Nevertheless, it is realistic to expect that any agency large enough to support its own system would want to do so in order to gain control of scheduling, maintenance, and resource allocation parameters.

Recommendations Specific to Chanute

Chanute CBE operations. The seven recommendations on this topic are restated here in abbreviated form:

1. In this recommendation the authors state that "PLATO applications should be selectively expanded to other course areas where CAI capabilities might be used to solve training problems, increase instructional efficiency, reduce training resource requirements, etc." They also suggest roles for specific organizational units at Chanute and advocate the development of a detailed plan to guide expansion of PLATO applications.

2. The authors recommend the self-pacing of the shred areas of the SPVC to take advantage of CBE's individualized nature, limit the need for enrichment materials and provide

for more efficient use of available terminals. Although this recommendation could lead to additional time savings, it would also entail purchase of additional training equipment. Nevertheless, it seems useful to prepare an analysis of projected costs and savings.

3. The authors recommend that terminal utilization be maximized by shifting surplus terminals to other courses to enable exploitation of cost-effective applications.

4. The report writers state that "Direct communication between authors and instructors should be promoted to facilitate application of PLATO, and increase instructional efficiency." Perhaps increased use of the recently added "TERM-comments" and "lesson notes" features of the PLATO system will help meet this need.

5. This item is a recommendation to install indirect lighting in the CBE classroom to eliminate problems of glare. As indicated in our critique of Chapter VIII, directed beams of vertical light are preferable to indirect light in this case.

6. This item recommends a reduction in the instructor force in the common course segment of the SPVC or some use of less expensive instructor aid personnel.

Some additional remarks seem in order regarding recommendation #1. Though we don't have the appropriate background to comment on the roles suggested for the various organizations noted, we concur with the general approach. We agree heartily that "PLATO applications should be selectively expanded to other course areas where CAI capabilities might be used to solve training problems." We believe that management and instructor acceptance of PLATO might have been significantly enhanced if it had been introduced as a tool to solve a training problem perceived by staff in both groups.

Similarly, the effectiveness benefits might have outweighed the costs if the chosen course had contained

unsolved problems relating to training effectiveness or training expense. Chanute attempted to squeeze higher efficiency from a training program which was already reasonably optimized. The sophisticated and expensive technology that they used to do this required that they realize substantial gains. Chanute staff should not be criticized, however, for the choice of a course to implement PLATO, nor for their decision to use it as the central medium for teaching. The many constraints on them, plus the conventional wisdom of that time dictated these factors. However, in a document making recommendations for future projects and sites, it is very important to stress the application of CBE for attacking unsolved training problems rather than as the "medium of preference" for implementing all new instructional materials.

Development of CAI materials. Five recommendations regarding courseware development and validation are offered. They are restated here for the reader's convenience. According to the authors:

1. The PLATO microfiche procurement process should be analyzed, then improved for greater efficiency. Toward this end, a new microfiche camera is being developed at CERL.

2. Redesign of the microfiche projector might eliminate focus and registration problems.

3. CBE courseware should be developed through a team approach using specialists who have overlapping knowledge of other team member's roles in the lesson development process.

4. A training program should be provided for individuals who perform courseware development functions. This program would emphasize instructional programming concepts for preparing individualized materials.

5. Instructor and supervisor involvement should be increased in the review and revision of PLATO courseware.

We concur that a training program for instructional design is needed for courseware developers (#4). We also feel that training for the managers of the developers is needed. When the Chanute project was started, no such training was available; in fact, the knowledge base from which to train staff was largely incomplete. With the experience gained from the implementation of PLATO IV, it is now reasonable to begin this task.

It is not clear whether the order of the recommendations indicates their perceived importance. We would rank the suggestions for an instructional design training program (#4), a team approach to courseware development (#3) and instructor/supervisor involvement (#5) ahead of the suggestions about microfiche redesign.

PLATO Applications

Suggestions for how to use PLATO in future projects are some of the most important results to be delivered by an implementation/research project such as this. The applications suggested by the authors appear to have potential for cost-effectiveness. A more extensive list of potentially cost-effective uses for CBE is contained in a list of CBE site management guidelines (Francis, 1977b).

Some Final Remarks

The comments by the authors in this section are a fitting summary to a well-written report on an extensive undertaking. We would like to add a few general remarks.

Readers of this (and other) reports of the use of CBE systems should consider that the results obtained are rather sensitive to the conditions of the implementation. Variations in the attitudes of the instructors, the quality of the

lessons, student-pacing modes, and the integration of CBE materials with instruction presented by other media can strongly influence outcomes and results.

Although some of the situations described in the report are necessarily related to conditions found only at Chanute or only with the SPVC, in general, the problems encountered are not uncommon or improbable, nor were the solutions used atypical or unlikely to be tried elsewhere.

We would like to take this opportunity to again commend the project evaluators and the writers of this report for a significant accomplishment of a difficult task. One of the main benefits of the Chanute research is the extensive database it generated. Supplementary analyses of this data are underway at CERL and are expected to lead to additional reports on CBE and related topics.

While we concur with the third of the overall conclusions of the AFHRL report (i.e., "[l]ittle in the way of new training capabilities was demonstrated"), we suggest that readers of the AFHRL report <u>not</u> view the Chanute experience as an example of how training can be structured around a CBE system to take maximum advantage of its capabilities, but as an example of how PLATO can be incorporated into a traditional military training environment without causing changes in basic routines.

LIST OF REFERENCES

Avner, R. A., & Misselt, A. L. Summary and critical analysis of USAOC&S CBE project evaluation. In H. A. Himwich (Ed.), Summary and critical analysis of Aberdeen CBE project. Urbana, Ill.: University of Illinois, Computer-based Education Research Laboratory, 1977.

Call-Himwich, E. Analysis of Aberdeen courseware. In H. A. Himwich (Ed.), Summary and Analysis of Aberdeen CBE project. Urbana, Ill.: University of Illinois, Computer-based Education Research Laboratory, 1977.

Campbell, D. T., & Stanley, J. C. Experimental and quasi-experimental designs for research. In N. L. Gage (Ed.), Handbook of research on teaching. Chicago: Rand McNally, 1963.

Cochran, W. G. Errors of measurement in statistics. Technometrics. 1968, 10(4), 637-666.

Cronbach, L. J. Course improvement through evaluation. Teachers College Record, 1963, 64, 103-109.

Dallman, B. E., DeLeo, P. J., Main, P. S., & Gillman, D. C. Evaluation of PLATO IV in vehicle maintenance training. (AFHRL -TR- 77-59) Lowry Air Force Base, Colorado 80230: Air Force Human Resources Laboratory, Technical Training Division, 1977.

Department of the Army. Evaluation of the PLATO IV system in a military training environment. Aberdeen Proving Grounds, MD: U. S. Army Ordnance Center and School, 1975.

Francis, L. Guidelines for establishing and managing a computer-based education site. Urbana, Ill.: University of Illinois, Computer-based Education Research Laboratory, 1977b.

Francis, L. PLATO IV terminal peripheral devices. Urbana, Ill.: University of Illinois, Computer-based Education Research Laboratory, 1976a.

Francis, L. The TUTOR training course: Lessons learned. Urbana, Ill.: University of Illinois, Computer-based Education Research Laboratory, 1976b.

Francis, L. A comparison of the costs for illustrations presented by the plasma panel and microfiche. Urbana, Ill.: University of Illinois, Computer-based Education Research Laboratory, 1977a.

Green, J. S. One year interim report on the AFHRL-ATC PLATO IV service test: 1972-1973. (TR CH 73-622) Chanute Air Force Base, Ill. 61868: USAF School of Applied Aerospace Sciences, Training Research Applications Branch, March 1973.

Himwich, H. A. The Chanute AFB PLATO service test: Site history and management. In H. A. Himwich (Ed.), Critique and summary of the Chanute AFB CBE project. Urbana, Ill.: University of Illinois, Computer-based Education Research Laboratory, 1977a.

Himwich, H. A. Some aspects of project establishment and management. In H. A. Himwich (Ed.), Summary and analysis of Aberdeen CBE Project. Urbana, Ill.: University of Illinois, Computer-based Education Research Laboratory, 1977b.

Kirk, R. E. Experimental design: Procedures for the behavioral sciences. Belmont, CA.: Brooks/Cole, 1968.

Klecka, J. A. An overview of chanute lessons. Urbana, Ill.: University of Illinois, Computer-based Education Research Laboratory, 1977a.

Klecka, J. A. Three aspects of PLATO use at Chanute AFB. Urbana, Ill.: University of Illinois, Computer-based Education Research Laboratory, 1977b.

Klecka, J. A. Military instructor attitudes toward computer-based technical training. In A. L. Misselt (Ed.), User attitudes toward CBE in a military technical training setting. Urbana, Ill.: University of Illinois, Computer-based Education Research Laboratory, 1977c.

Lyman, E. R. PLATO highlights (5th Ed.). Urbana, Ill.: University of Illinois, Computer-based Education Research Laboratory, 1977.

Misselt, A. L. The effects of measurement error on analysis of covariance with multiple covariates. Unpublished doctoral dissertation, University of Illinois, 1977.

Popham, W. J. Criterion referenced measurement. Englewood Cliffs, N. J.: Educational Technology Publications, Inc., 1971.

Salomon, G. & Clark, R. E. Reexamining the methodology of research on media and technology in education. Review of Educational Research, 1977, 47, 99-120.

Seidel, R. J. Learner control of instructional sequencing within an adaptive tutorial CAI environment (HumRRO Tech. Rep. 75-7). Alexandria, Va.: Human Resources Research Organization, June, 1975.

Smith, S., & Sherwood, B. A. Educational uses of the PLATO computer system. Science, April 23, 1976, pp. 344-352.

Steinberg, E. R. Review of student control in computer-assisted instruction. Journal of Computer Based Instruction, in press.

Tatsuoka, K., Misselt, A. L., & Maritz, P. Attitudes and performance of military students in computer-based technical training. In A. L. Misselt (Ed.), User attitudes toward CBE in a military technical training setting. Urbana, Ill.: University of Illinois, Computer-based Education Research Laboratory, 1977.

Tatsuoka, K. Approaches to validation of criterion referenced tests and computer-based instruction in a military project. Urbana, Ill.: University of Illinois, Computer-based Education Research Laboratory, 1977.

Tatsuoka, M. M. Multivariate analysis: Techniques for educational and psychological research. New York: Wiley, 1971.